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COMPILATION, DESIGN TESTS
ENERGETIC PARTICLES SATELLITE S-3
INCLUDING DESIGN TESTS
FOR S-3A, S-3B AND S-3C

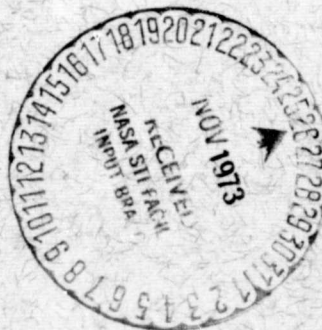
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BY
F. N. LeDOUX



GODDARD SPACE FLIGHT CENTER
GREENBELT, MD.

**COMPILATION, DESIGN TESTS
ENERGETIC PARTICLES SATELLITE S-3
INCLUDING DESIGN TESTS FOR S-3A, S-3B AND S-3C**

**BY
FRANCIS N. LeDOUX**

**GODDARD SPACE FLIGHT CENTER
GREENBELT, MD.**

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FOREWORD

A compilation of engineering design tests that were conducted in direct support of the Energetic Particle Satellite S-3 - S-3A and S-3B programs by the personnel of the Structural and Mechanical Applications Section, Mechanical Systems Branch, Spacecraft Intergration and Sounding Rocket Division, Space Sciences and Satellite Applications Directorate is herein contained.

The prime purpose of conducting these engineering design tests was to insure, to the highest possible degree, the adequacy and reliability of the Energetic Particles series of satellites designs. In all cases conclusions made as a result of these tests were those of the test requestor.

Francis N. LeDoux

I - MOMENTS OF INERTIA S-3
MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-1
JM P.E.
FTM S.H.
RCB B.H.

INFORMAL TEST REPORT

Name of Test: Moment of Inertia

Date of Test: 1 Dec. 60

Requested by: J. Madey

Performed by: W. E. Smith

Purpose of Test: To determine moment of inertia of S-3 structural prototype.

Description of Article Tested (Photographs, if any):

S-3 structural prototype

Test Equipment (Photographs, if any):

Moment of inertia standard set up. 72# wts.
I of fixture = 0.3 slug-ft²

Test Procedure:

The 72# weights were clocked on the brass rod set up and recorded. Then the payload was set up and timed and recorded. These values were used in moment of inertia formula

$$\left[I_p = \frac{I_D (T_p)^2}{T_D} \right]$$

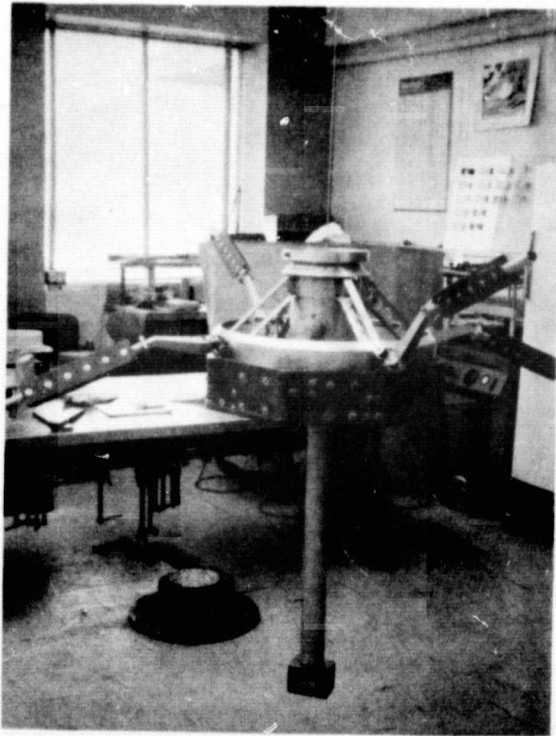
and results calculated.

Two tests were run: one with arms folded and one with arms extended. Both times the payload was suspended upside down.

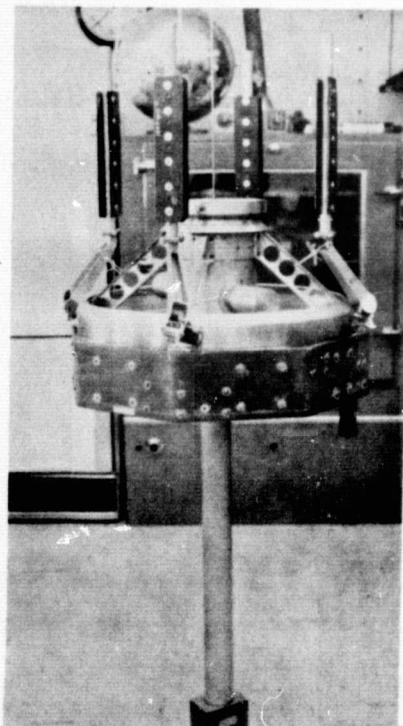
Results:

1. Arms extended $I_p = 3.3$ slug-ft²
2. Arms folded $I_p = 1.4$ slug-ft²

Conclusions:



Test No. 1



Test No. 2

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-2
JM P.E.
FTM S.H.
RCB B.H.

Name of Test: Moments of Inertia

Date of Test: 2 Dec. 60

Requested by: J. Madey

Performed by: W. E. Smith, Jr.

Purpose of Test: To determine moment of inertia.

Description of Article Tested (Photographs, if any):

S-3 structural prototype.

Test Equipment (Photographs, if any):

.067 music wire

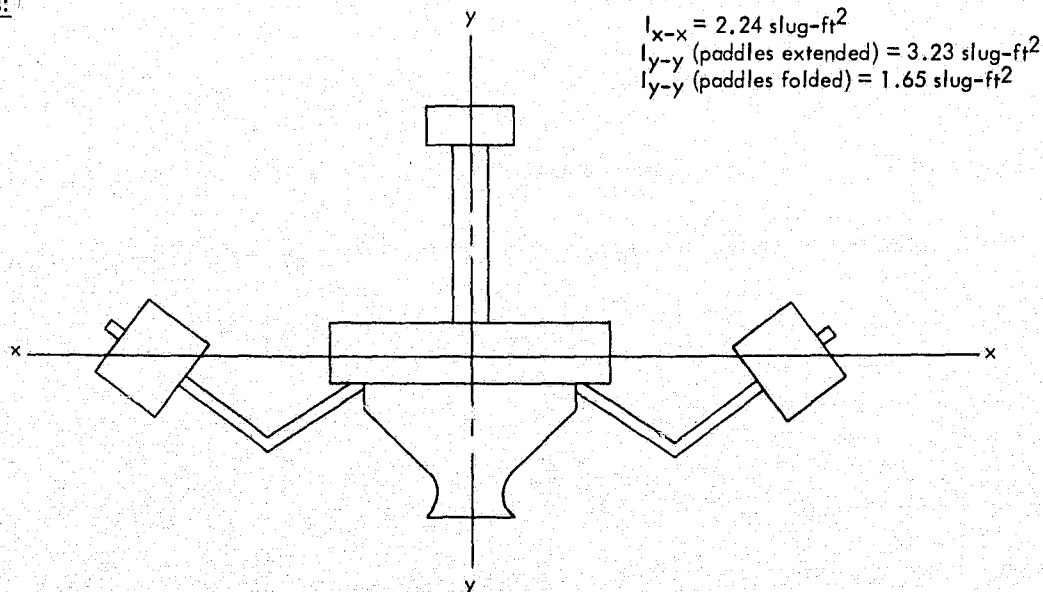
72# Disc $I_D = .022$ slug-ft²

Test Procedure:

Paddle weights were trimmed so that the struts weighed 1232.1 g/strut. Payload was set up to revolve around X-X axis and timed for 8 sets of 5 revolutions and an average time (T_p) found for one period. Then payload was set-up to revolve on Y-Y axis with first paddles folded and then paddles extended. Data was tabulated and inertia computed.

$$I_p = \frac{I_D (T_p)^2}{(T_D)^2} - I_{\text{FIXTURE}}$$

Results:



Conclusions:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-11
JM P.E.
FTM S.H.
RCB B.H.

INFORMAL TEST REPORT

Name of Test: Moment of Inertia (Paddle Arms)

Date of Test: 28 Dec. 60

Requested by: J. Madey

Performed by: L. E. Paul

Purpose of Test: To determine inertia of an arm and paddle assembly about a hinge point.

Description of Article Tested (Photographs, if any):

Low arms and paddles.
High arms and paddles.

Test Equipment (Photographs, if any):

9.094# Disc with .049 dia. wire 46.5" long
.141" dia. wire 47.5" long

Test Procedure:

Take time of oscillations of high paddles, low paddles, test disc only, with .049" wire and .141" rod each.

$$I = I_{\text{Disc}} \left[\left(\frac{T_{\text{Both}}}{T_{\text{Disc only}}} \right)^2 - 1 \right]$$

Results:

Low arms and paddles/.049" wire $I = 0.35$ slug-ft²
High arms and paddles/.049" wire $I = 0.45$ slug-ft²
Low arms and paddles/.141" rod $I = 0.34$ slug-ft²
High arms and paddles/.141" rod $I = 0.45$ slug-ft²

Conclusions:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-12

JM	P.E.
FTM	S.H.
RCB	B.H.

9/14

Name of Test: Moment of Inertia (Paddle Assembly)

Date of Test: 30 Aug. 60

Requested by: J. Madey

Performed by: W. Smith, Berkeley, Corbin

Purpose of Test: To determine the moment of inertia of a solar cell paddle assembly.

Description of Article Tested (Photographs, if any):

Spars, Bracket and Disc with added wts. for test.

Test Equipment (Photographs, if any):

.048 music wire - 36" long, standard setup.
#9.094 Disc with known moment of inertia.

Test Procedure:

Time oscillations of Disc, repeated 5 times, average 79.8
Time oscillations of Disc and brkt. 5 times, average 80.4
Time oscillations of Disc, brkt. and spar repeated 5 times, average 110.5
Time oscillations of Disc, arms, brkt. and 909 wts., repeated 5 times, average 150.5
Time oscillations of Disc, arms, brkt. and 733 wt., repeated 5 times, average 225.6

Results: (Photographs, if any):

$I = 14.48$ slug-in²

$I = 14.48$

Disc, arms, brkt. and
909 wts. (Modules)

$$J = 14.48 \left[\left(\frac{150.5}{79.8} \right)^2 - 1 \right]$$

$$J = 14.48 \left[\left(\frac{225.6}{79.8} \right)^2 - 1 \right]$$

Disc, arms and brkt. and wts.
(Module and Magnetometer wts.)

$I = 14.48$

$$J = 14.48 \left[\left(\frac{110.5}{79.8} \right)^2 - 1 \right]$$

Disc, arms, and brkt.

$I = 14.48$

Disc and bracket

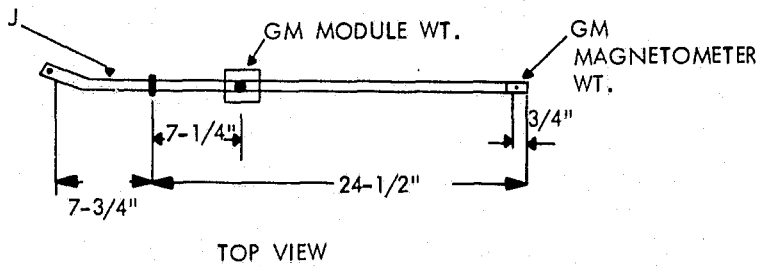
$$J = 14.48 \left[\left(\frac{80.4}{79.8} \right)^2 - 1 \right]$$

Arm, brkt., module wt. and mag. wt. $J = 101.244/2 = 50.62 \text{ slug-in}^2$

Arm and brkt. $J = 13.293/2 = 6.65 \text{ slug-in}^2$

Bracket $J = .2317/2 = .11 \text{ slug-in}^2$

Arms, brkt. and module wt. $J = 37.03/2 = 18.51 \text{ slug-in}^2$



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-13

JM	P.E.
FTM	S.H.
RCB	B.H.

INFORMAL TEST REPORT

Name of Test: Moment of Inertia and Preliminary Static Balance

Date of Test: 2 Feb. 61

Requested By: J. Madey

Performed by: L. E. Paul and W. E. Smith, Jr.

Purpose of Test: To determine static balance and moment of inertia of prototype.

Description of Article Tested (Photographs, if any):

S-3 Delta Prototype.

Test Equipment (Photographs, if any):

Two scales and cables with holding fixture for static balance.
Moment of Inertia set-up
Stop watches.

Test Procedure:

I. Static Balance.

With holding fixture on opposite struts payload was hung on two scales (SK-1). Prototype was then rotated 90° and 180° as a check. This was done without solar paddles and arms.

II. Moment of Inertia.

Using the standard moment of inertia set-up, moment of inertia was calculated for payload with and without paddles.

Results:

With paddles

$$I_{spin} = 3.387 \text{ slug-ft}^2$$

Without paddles

$$I_{spin} = 1.397 \text{ slug-ft}^2$$

Conclusions:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 300-17
JM P.E.
FTM S.H.
RCB B.H.

Name of Test: Moment of Inertia (Paddle Assemblies)

Date of Test: 23 Feb. 60

Requested by: J. Madey

Performed by: L. Paul

Purpose of Test: To determine moment of inertia of upper and lower paddle assemblies.

Description of Article Tested (Photographs, if any):

Upper and Lower paddle assemblies.
See photographs #1, #2, #3, #4.

Test Equipment (Photographs, if any):

Standard inertia test rig. $I = 0.072 \text{ slug-ft}^2$

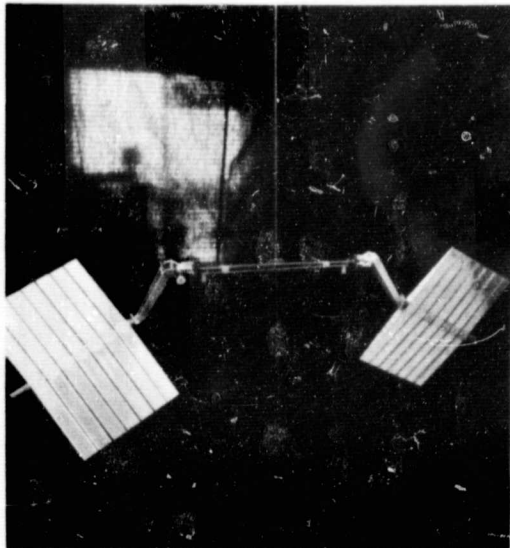
Test Procedure:

Assembly was suspended from test rig., given 5° -twist and released. After a specified number of oscillations, time was noted, and averaged for a single cycle.

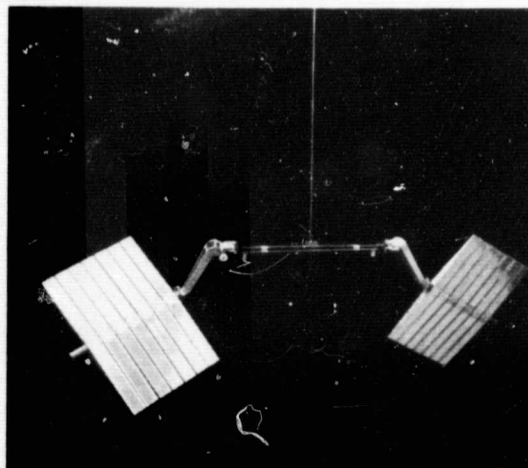
Results:

Lower paddles extended	$I = 0.962 \text{ slug-ft}^2$
Lower paddles folded	$I = 0.216 \text{ slug-ft}^2$
Lower arms	$I = 0.075 \text{ slug-ft}^2$
Upper paddles extended	$I = 1.138 \text{ slug-ft}^2$
Upper paddles folded	$I = 0.291 \text{ slug-ft}^2$
Upper arms	$I = 0.083 \text{ slug-ft}^2$

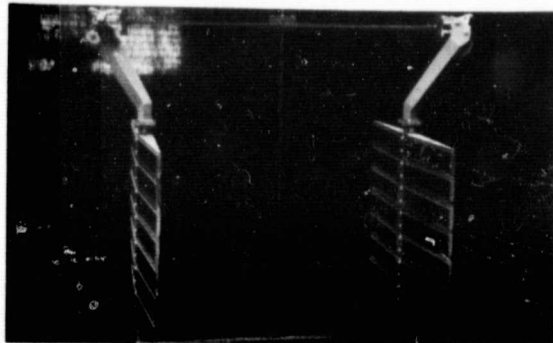
Conclusions:



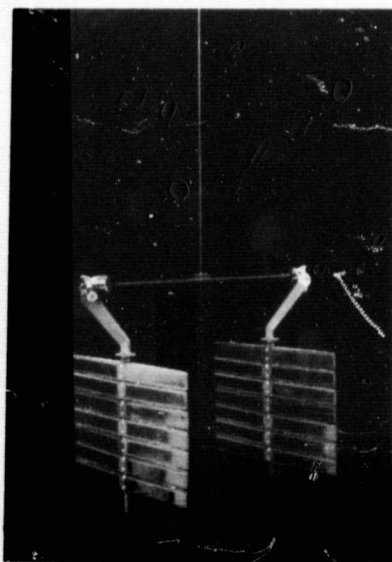
Extended Upper



Extended Lower



Folded Upper



Folded Lower

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 300-26
JM P.E.
FTM S.H.
RCB B.H.

Name of Test: Moment of Inertia (Varied Configuration)

Date of Test: 15 March 61

Requested by: J. Madey

Performed by: L. Paul

Purpose of Test: To determine moment of inertia of S-3 prototype with solar paddles folded and extended.

Description of Article Tested (Photographs, if any):

Prototype

Test Equipment (Photographs, if any):

Standard moment of inertia test rig

Test Procedure:

Payload was suspended from test fixture and time noted as it oscillated for a given number of cycles.

An aluminum disc 12" diameter and 22# with $I_{Disc} = .0854 \text{ slug-ft}^2$ was used for computation in formula.

$$\frac{I_{Payload}}{T_{Payload}} = \frac{I_{Disc}}{T_{Disc}}$$

$T_{Disc} = 1.166 \text{ Sec/cycle.}$

Results:

	PADDLES EXTENDED	PADDLES FOLDED
SPIN AXIS	3.493 slug-ft ²	= 1.868 slug-ft ²
#1 and #3 paddle axis	2.471 slug-ft ²	= 2.262 slug-ft ²
#2 and #4 paddle axis	2.708 slug-ft ²	= 2.336 slug-ft ²

Conclusions:

MECHANICAL SYSTEMS BRANCH

SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-39

JM	P.E.
FTM	S.H.
RCB	B.H.

6/1/61

Name of Test: Moment of Inertia of S-3 StructureDate of Test: 9 May 61Performed by: W. Smith, Cotton Drew, L. PaulPurpose of Test: To determine the moment of inertia of the S-3 structure (less experiments)Description of Article Tested (Photographs, if any):

See attached photos
(Note: Model paddles weigh less than active paddles.)

Test Equipment (Photographs, if any):

See attached photos

Test Procedure:

Weight of lower structure assembly, 7.446 pounds. Weight of payload without experiments, 30.906 pounds.

Payload was suspended from test fixture and time noted as it oscillated for a given number of cycles. An aluminum disk 14" diameter and weighing 50 pounds whose I is equal to slug-ft² was used to compute the following problems. $I_{C.D.} = .264$ $T_{C.D.} = 2.079$

De-Spin Test, payload (S-3)

I_{1-3} axis		I_{2-4} axis	
$\frac{I_{1-3}}{T_{1-3}^2} = \frac{I_{C.D.}}{T_{C.D.}^2}$		$\frac{I_{2-4}}{T_{2-4}^2} = \frac{I_{C.D.}}{T_{C.D.}^2}$	
$\frac{I_{1-3}}{T_{1-3}^2} = \frac{.264}{4.326}$		$\frac{I_{2-4}}{20.612} = \frac{.264}{4.326}$	
$I_{1-3} = \frac{.264 \times 22.468}{4.326}$		$I_{2-4} = \frac{.264 \times 20.612}{4.326}$	
$I_{1-3} = 1.371$ w/fix. .010		$I_{2-4} = 1.258$ w/fix. .010	
True $I_{1-3} = 1.361$ slug ft ²		True $I_{2-4} = 1.248$ slug ft ²	

I Spin

$\frac{I_{Spin}}{T_{Spin}^2} = \frac{I_{C.D.}}{T_{C.D.}^2}$	$\frac{I_{Spin}}{35.284} = \frac{.264}{4.326}$
$I_{Spin} = \frac{.264 \times 35.284}{4.326}$	$I_{Spin} = 2.153$ w/fix. .006
	True $I_{Spin} = 2.147$ slug ft ²

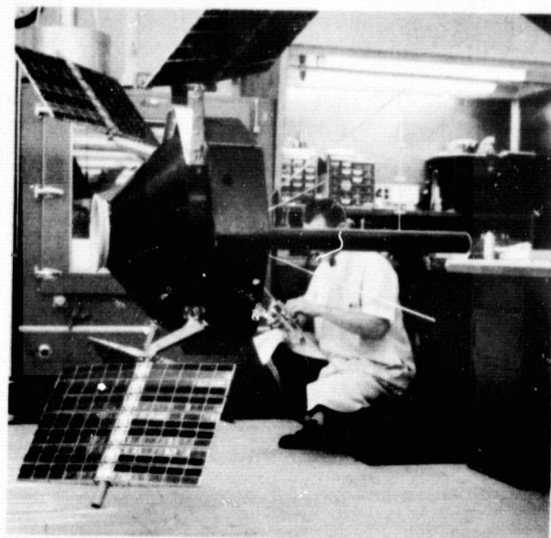
Results: (Photographs and graphs, if any):

Conclusions:

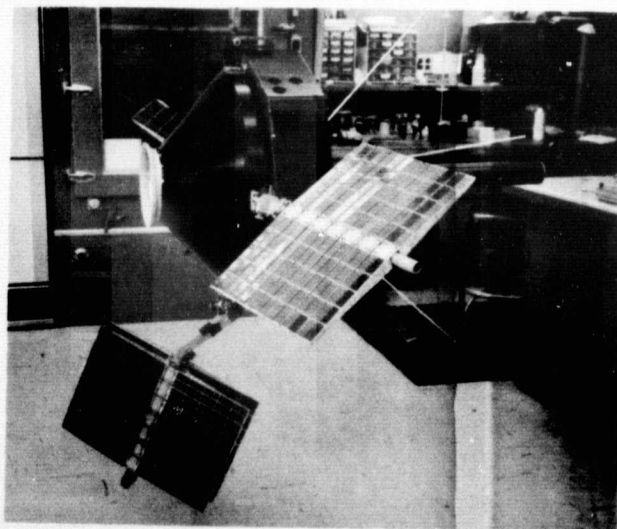
C. G. - O - from base $9-7/8'' \pm 1/16$
C. G. paddles ext. high paddle $10''$ low paddle $10-3/32''$
C. G. paddles ext. (between 3 and 4 arms.) $10-3/32'' \pm 1/16$
I 1-3 paddles ext. = $1.361 \text{ slug-ft}^2 \pm 0.01$
I 2-4 paddles ext. = $1.248 \text{ slug-ft}^2 \pm 0.01$
I spin = $2.147 \text{ slug-ft}^2 \pm 0.01$

The above data is for the S-3 structure with dummy paddles, a more realistic test should include either the live paddles or dummy paddles with realistic weights.

J. Madey



Moment of Inertia Test Set-up



Moment of Inertia Test Set-up

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-46

JM P.E.

FTM S.H.

RCB B.H.

6/1/61

Name of Test: Moment of Inertia (Rod - Versus - Wire)

Date of Test: 29 Dec. 60

Requested by: J. Madey

Performed by: L. E. Paul

Purpose of Test: Accuracy of rod versus wire method
of measuring moment of inertia.

Description of Article Tested (Photographs, if any):

22 lb. disc with known moment of inertia.

Test Equipment (Photographs, if any):

22 lb. disc, 50 lb. disc, .140 dia. rod, .049 dia. wire and std. set up.

Test Procedure:

Using .049 dia. wire, average cycle time of 50 lb. disc for 20 cycles was 29.49 sec.

Using .141 dia. rod, average cycle time of 50 lb. disc for 20 cycles was 5.59 sec.

Using .049 dia. wire, average cycle time of 22 lb. and 50 lb. discs for 20 cycles was 33.93 seconds.

Using .141 dia. rod, average cycle time of 22 lb. and 50 lb. discs for 20 cycles was 6.44 seconds.

Results: (Photographs and graphs, if any):

I = moment of 22# disc

I_D = moment of 50# disc

$T_{\text{Disc only}}$ = time of 50# disc

W/.049 Dia. Wire

$$I = I_D \left[\left(\frac{T_{\text{Both}}}{T_{\text{Disc only}}} \right)^2 - 1 \right]$$

$$I = .26 \left[\left(\frac{33.93}{29.49} \right)^2 - 1 \right]$$

$$I = .26 \times .32$$

$$I = .0832 \text{ slug ft}^2$$

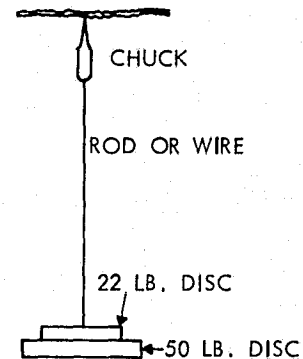
W/.141 Dia. Rod

$$I = I_D \left[\left(\frac{T_{\text{Both}}}{T_{\text{Disc only}}} \right)^2 - 1 \right]$$

$$I = .26 \left[\left(\frac{6.44}{5.59} \right)^2 - 1 \right]$$

$$I = .26 \times .32$$

$$I = .0832 \text{ slug ft}^2$$



Wire or Rod dia.	Disc #1 I = .26 sl.ft? wt. = 50 lb.	Disc #2 I = .0854 sl.ft? wt. = 22 lb.	Average cycle time Disc # 1	Average cycle time Disc # 1 and # 2	Calculated "I" of disc #2
.049	✓	✓	29.49 sec.	33.93 sec.	.0832 sl.ft?
.141	✓	✓	5.59 sec.	6.44 sec.	.0832 sl.ft?

Conclusions:

The moment of inertia measuring wire/rod can vary over a significantly wide range of diameter (~3:1) and still obtain comparable results (~3 significant figures.) If the elastic limit is not exceeded and you can tolerate the times involved, any diameter can be used.

JM

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 300-40
JM P.E.
FTM S.H.
RCB B.H.

Name of Test: Moment of Inertia (Yo-Yo De-Spin Test Rig and Paddle Erection Test Rig)

Date of Test: 11 May 61

Performed by: J. Sween

Purpose of Test: To determine the moment of inertia - yo-yo de-spin test rig and the paddle erection test rig.

Description of Article Tested (Photographs, if any):

Photographs included.

Test Equipment (Photographs, if any):

Photographs included.

Test Procedure:

The yo-yo de-spin test rig was suspended from the test fixture and the time noted as it oscillated for a given number of cycles. A disc whose I is equal to .264 and time squared 4.236 seconds was used to compute the moment of inertia.

The same procedure was used for finding the moment of inertia of the paddle erection test rig.

Results: (Photographs and graphs, if any):

Yo-yo de spin test rig - average time = 6.59

$$\frac{I_R}{T_R^2} = \frac{I_{CD}}{T_{CD}^2} \quad \frac{I_R}{43.2} = \frac{.264}{4.326} \quad I_R = 2.64$$

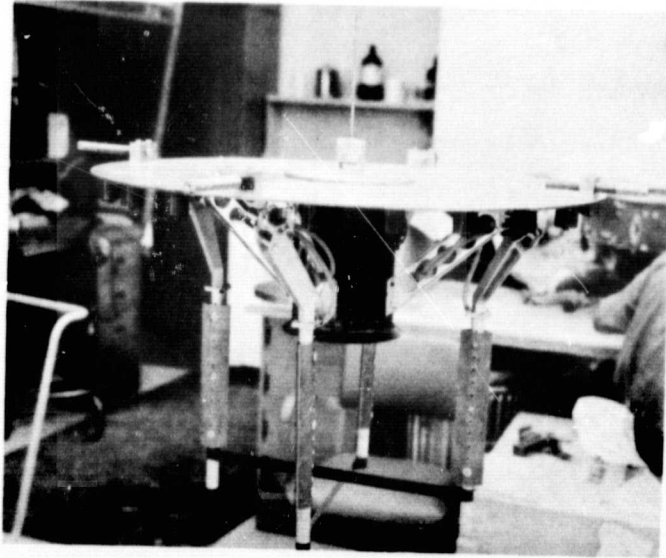
Paddle erection test rig

$$\frac{I_R}{T_R^2} = \frac{I_{CD}}{T_{CD}^2} \quad \frac{I_R}{44.8} = \frac{.264}{4.326} \quad I_R = 2.74$$

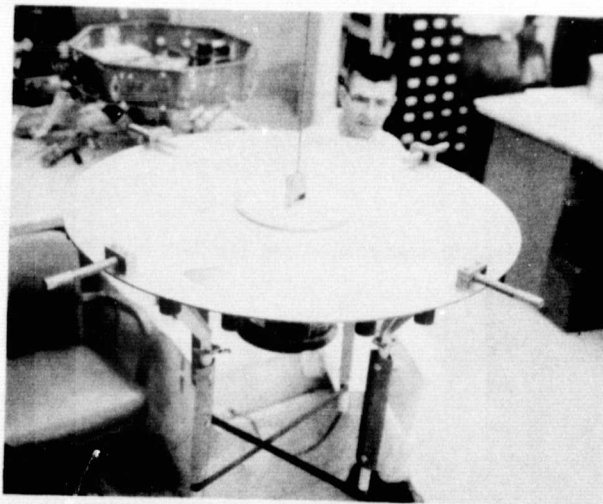
Conclusions:

The test indicated that the paddle erection test rig was adequate.

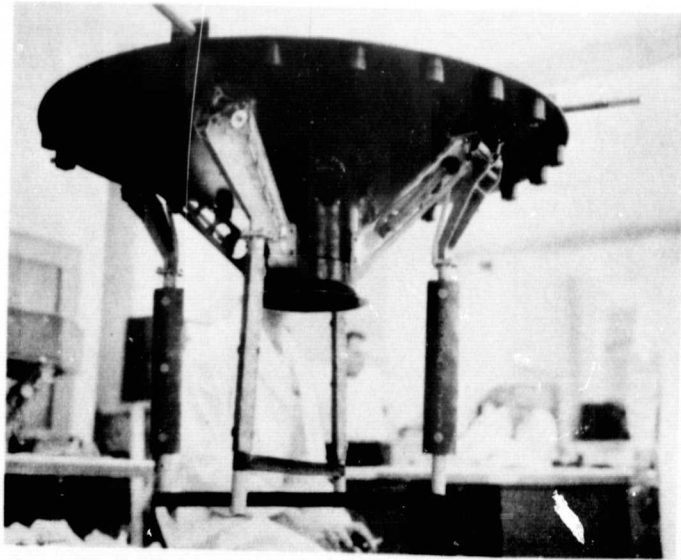
JM



Paddle Erection Test Rig



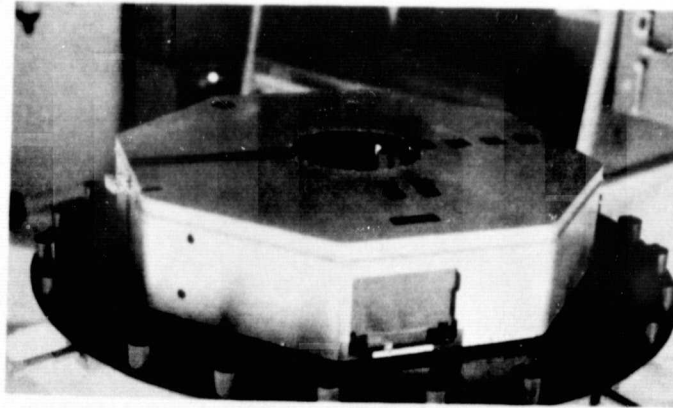
Paddle Erection Test Rig



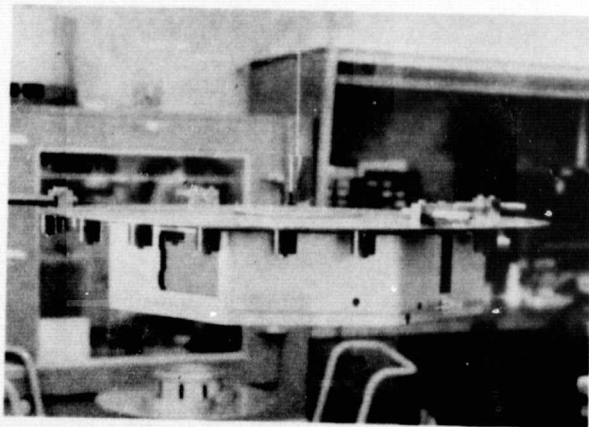
Paddle Erection Test Rig



Yo-Yo Despin Test Rig



Yo-Yo Despin Test Rig



Yo-Yo Despin Test Rig

MOMENTS OF INERTIA S-3A
MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-50	
JM	P.E.
FTM	S.H.
RB	B.H.

INFORMAL TEST REPORT

Name of Test: Moments of Inertia (Flight Unit)

Date of Test: 8 June 62

Performed by: Tony Pierro, Don Bower and Paul McConnell

Purpose of Test: Moments of inertia for selection of yo-yo's wts. and spin up rockets.

Description of Article Tested (Photographs, if any):

S-3A flight unit
weight 86.06 lbs. (static balanced only)

Test Equipment (Photographs, if any):

22 lb. disc with a known moment of 0.0854 slug-ft²
Mounting disc with a moment of .009 slug-ft²
3/16 dia. rod x 4 ft. long

Test Procedure:

1. Run standard disc with a known moment of 0.0854 slug-ft² for 50 osc. average osc. = 1.17 sec.
2. Run disc and marmon clamp, average osc. = 0.4 sec.
- I 3. Run complete payload with antennas opened, paddles folded with yo-yo's average osc. = 5.52 sec.
- II 4. Run complete payload with antennas opened, paddles folded without yo-yo's average osc. = 5.51 sec.
- III 5. Run complete payload with antennas and paddles opened without yo-yo's average osc. = 7.7 sec.

Results: (Photographs and graphs, if any):

$$\text{I} \quad I_P = \frac{I_D \times T_P^2}{T_D^2}$$

$$I_P = \frac{.0854 \text{ slug ft}^2 \times 30.47 \text{ sec}^2}{1.369 \text{ sec}^2} = 1.9 - .009 = 1.891 \text{ slug ft}^2$$

$$\text{II} \quad I_P = \frac{I_D \times T_P^2}{T_D^2}$$

$$I_P = \frac{.0854 \text{ slug ft}^2 \times 30.36 \text{ sec}^2}{1.369 \text{ sec}^2} = 1.894 - .009 = 1.885 \text{ slug ft}^2$$

$$\text{III} \quad I_P = \frac{I_D \times T_P^2}{T_D^2}$$

$$I_P = \frac{.0854 \text{ slug ft}^2 \times 59.29 \text{ sec}^2}{1.369 \text{ sec}^2} = 3.699 - .009 = 3.690 \text{ slug ft}^2$$

Conclusions:

These results are needed for preliminary yo-yo wt. calculations and for DAC spin rocket selection.

The final wt. and MOI will be obtained the early part of next month. This information will immediately be transmitted to Douglas.

JM 6/20/62.

Payload wt. without paddles and door 72-15/16 lbs.
Paddles and door 13-1/8 lbs.
 86-1/16 lbs.

Set up with 4' x 3/16" dia. rod and 22# .0854 slug-ft² disc.

Disc. 22# .0854 slug-ft²

50 osc.
58.2 sec.

50 osc.
58.6 sec.

50 osc.
58.3 sec.

50 osc.
58.6 sec.

Mounting disc .006 slug-ft² and marmon clamp

20 osc.
8 sec.

20 osc.
8 sec.

20 osc.
7.9 sec.

20 osc.
7.8 sec.

Payload with antennas open, paddles folded with yo-yo's.

10 osc.
55 sec.

10 osc.
55.4 sec.

10 osc.
55 sec.

10 osc.
55.4 sec.

No
Folio

Payload with antennas open, paddles folded without yo-yo's.

10 osc.
55 sec.

10 osc.
55 sec.

10 osc.
55.2 sec.

10 osc.
55.2 sec.

Payload with appendages open without yo-yo's.

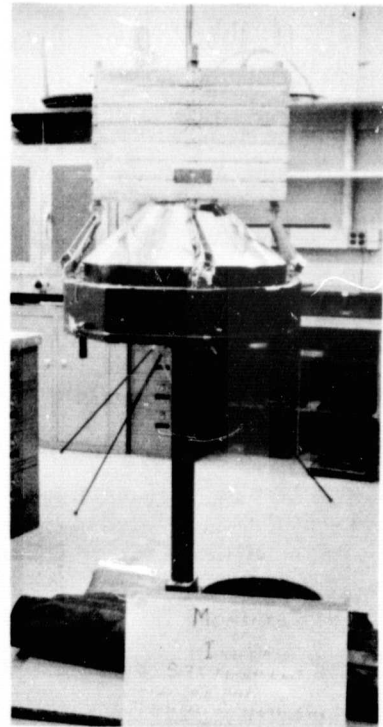
10 osc.
76.7 sec.

10 osc.
77 sec.

10 osc.
77.1 sec.

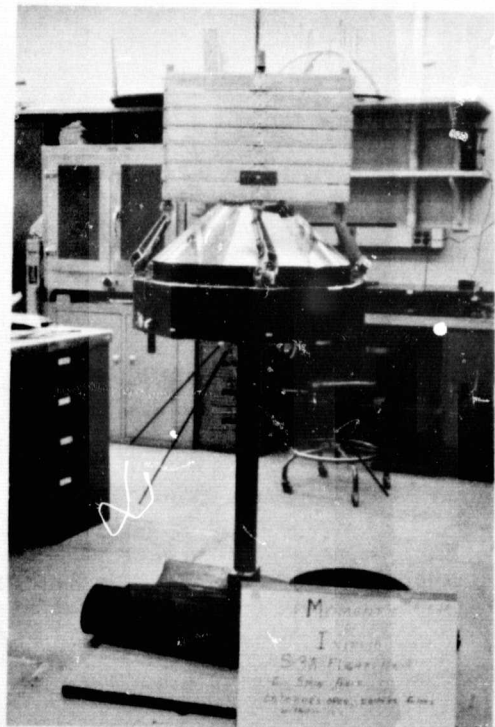
10 osc.
77 sec.

Run No. 1



Run No. 2

Run No. 3



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 1400-5
JHC P.E.
JM S.H.
FTM B.H.

Name of Test: Moment of Inertia Rig Calibration S-3A

Date of Test: 24 July 62

Requested by: J. Conn

Performed by: Tony Pierro, Don Bower

Purpose of Test: To determine if rig is suitable for both spin and lateral axis.

Description of Article Tested (Photographs, if any):

- Rod 1/4" dia. \times 41-1/2" long, wt. 9.5 lbs., C. G., 2.812" from axis
- 4 - plates, 4 - 1" bolts with Teflon washers; for spin axis
- 2 - pr. trunnions with 2-1/2" dia. bearings (roller), for lateral axis
- 1 - mounting plate for scout interface
- 1 - mounting plate for delta interface

Test Equipment (Photographs, if any):

- Stop watch
- 20 lb. standard, 8.45" sq. \times 1"
- 36 lb. standard, 11.31" sq. \times 1"
- 50.2 lbs. standard, 14" dia. \times 1" with known moment of 0.264 slug-ft²
- 90.59 lb. standard, 8" dia. \times 12" long cylinder, 1" wall thickness
- Knife edge to find C. G.

Test Procedure:

1. Suspension rod was placed on knife edge and found C. G., 2.812" from axis.
2. Rod was suspended with 2 wires, 0.014" dia., 60.5 long and 7-1/8" apart. Test run in torsion and pendulum, inertia of rod was found.
3. Torsion set up; using mounting plate, 4 brackets, 4 - 1" bolts with 1/16" thick Teflon washers between base of rod and brackets. Each standard was loaded 15° (degrees), 50 oscillations, 4 times.

50 lbs. standard, 50 osc. 51.8 sec.

90.59 lbs. standard, 50 osc. 46.85 sec.

4. Pendulum set up; 2 - trunnions with 1-1/2" dia. bearings (roller), with rod centrally spaced between trunnions, with race of bearings against base of rod. Light film of oil used on bearings (instrument oil). Trunnions marked as pairs, #1 and #2. #1 set used first (min angle 10°, max. 20°).

- a. Rod no nut 50 cyc. 91.5 sec.
- b. Rod with nut 50 cyc. 93.0 sec.
- c. Rod with delta plate (2.25 lbs.) 50 cyc. 98.0 sec.
- d. Rod with delta plate + 50.2 lbs. (standard) 50 cyc. 101.4 sec.
- e. Rod with 20 lbs. standard 50 cyc. 100.32 sec.
- f. Rod with 36 lbs. standard 50 cyc. 100.92 sec.
- g. Rod with 50.2 lbs. standard 50 cyc. 101.2 sec.
- h. Rod with 90.59 lbs. standard 50 cyc. 108.3 sec.

5. Pendulum same as number four, trunnion and bearing sets #2 located 90° from previous run. Same results.

6. Torsion rod set up with 600 lbs. of wt. and checked for strength.

Results:

Using the following formula and the inertia of the calibration blocks the apparent inertia of the pendulum was plotted: (see graph)

$$I_C = \left(\frac{T}{6.283} \right)^2 (26.710 + W_C h_C) - I_P - \frac{W_C h_C^2}{385.87} - .193 - I_D$$

I_C = inertia of block - in # sec²

I_P = apparent inertia of pendulum

T = period - sec.

W_C = weight of block - #

h_C = height of C. G. of block from axis of rotation

I_D = inertia of attachment fixtures

For the torsional mode the inertia rig the spring constant K was calculated at 116.72 # in./rod, using the formula

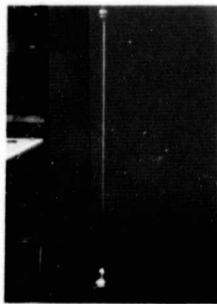
$$I_C = K \left(\frac{T}{6.283} \right)^2$$

Conclusions:

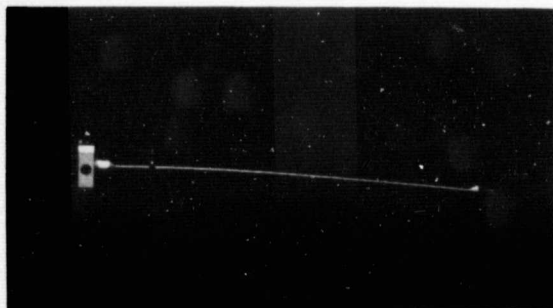
The inertia rig can be used to determine the inertia of satellites in the roll, pitch, and yaw axis.

The accuracy in the roll axis is extremely good; 99.9%. The accuracy in the pitch and yaw axis is about 98 to 99% depending on the procedure of set up on the bearing and the precision of time measurement.

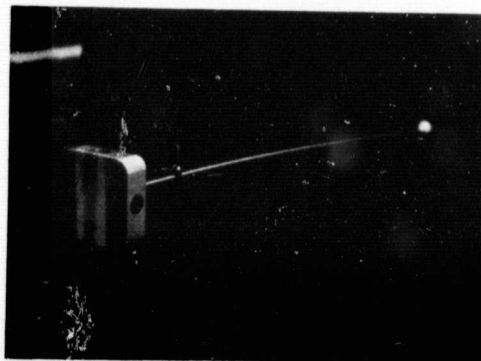
JHC



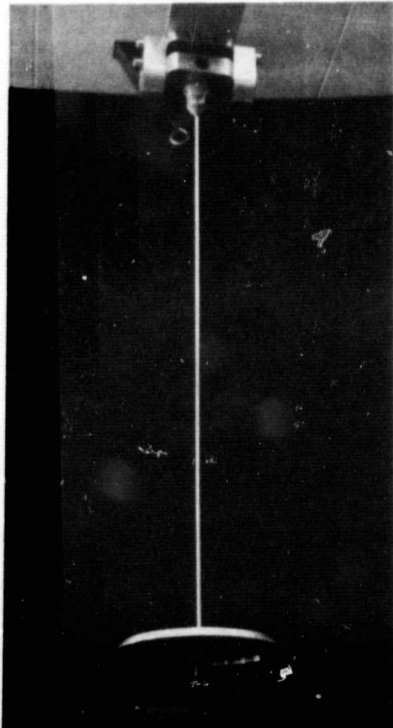
1/4" Rod and
Mounting Block



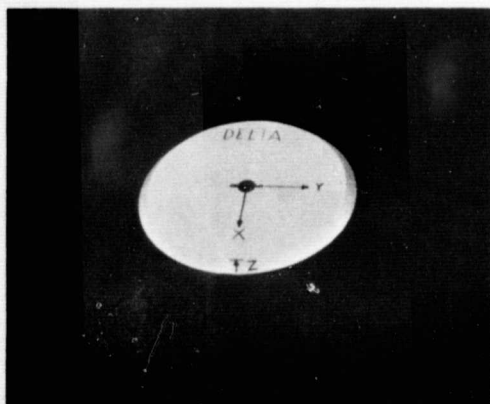
Obtaining C.G. of Rod and Mounting Block



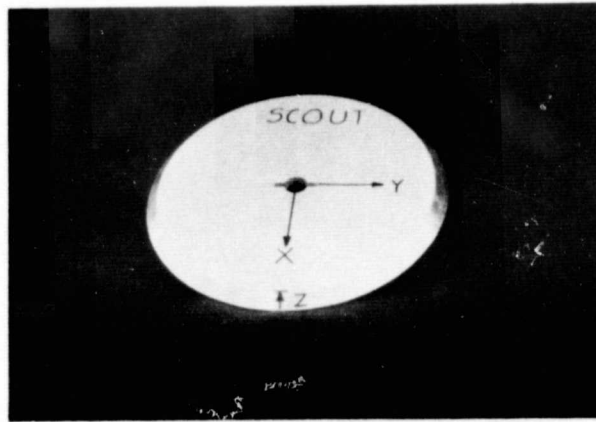
Obtaining C.G. of Rod and Mounting Block



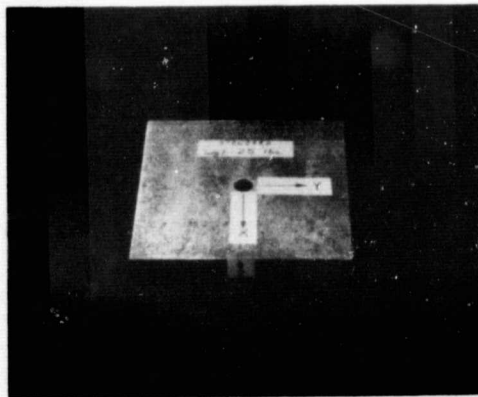
Pendulum Set-up



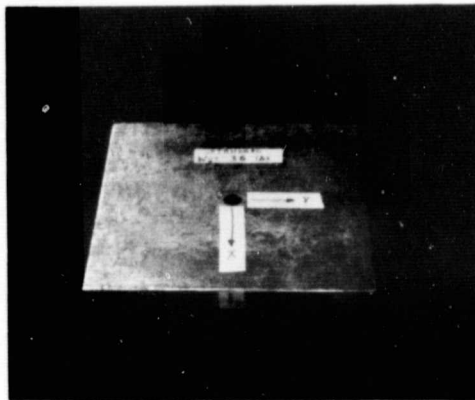
Mounting Plate for Delta Interface



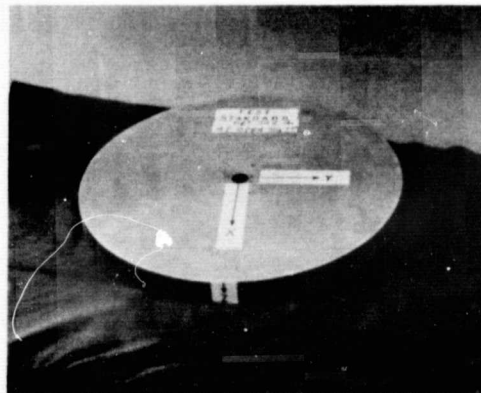
Scout Interface



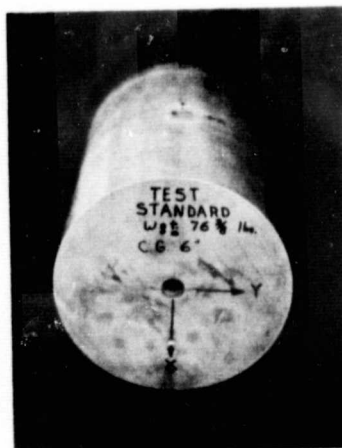
25 lbs. Standard for Moment of Inertia



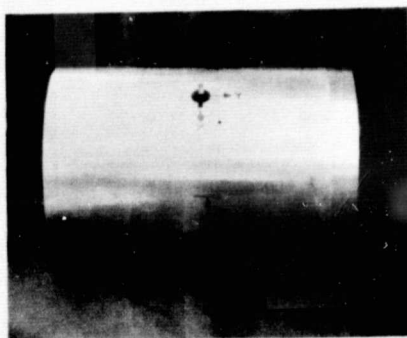
36 lbs. Standard for Moment of Inertia



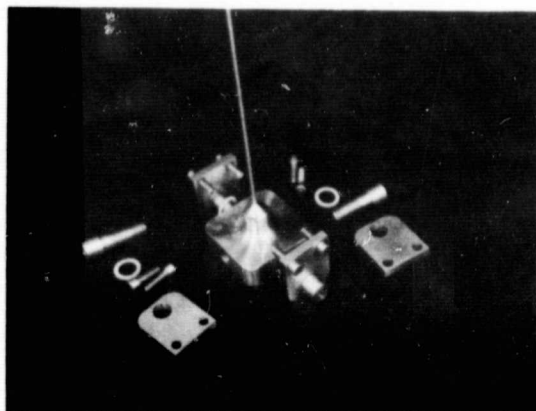
50.2 lbs. Standard for Moment of Inertia



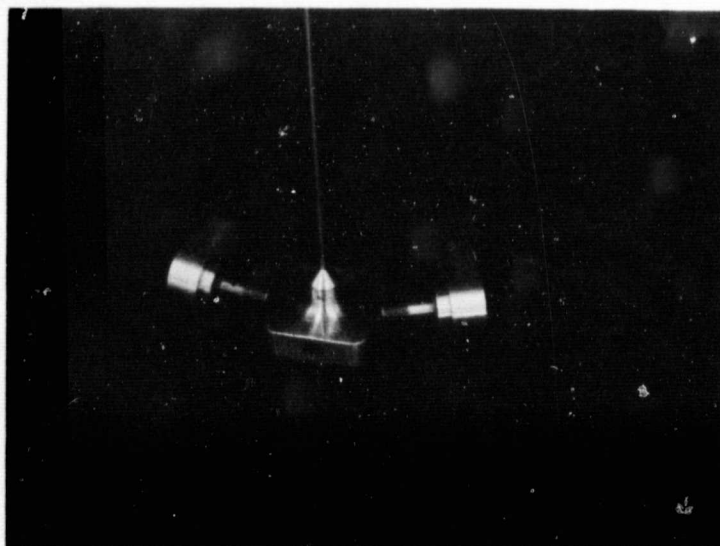
76 3/8 lbs. Standard for
Moment of Inertia



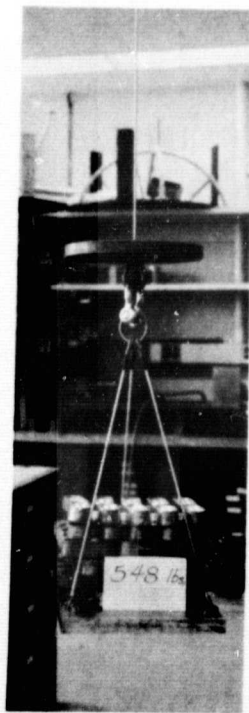
76 3/8 lbs. Standard for
Moment of Inertia



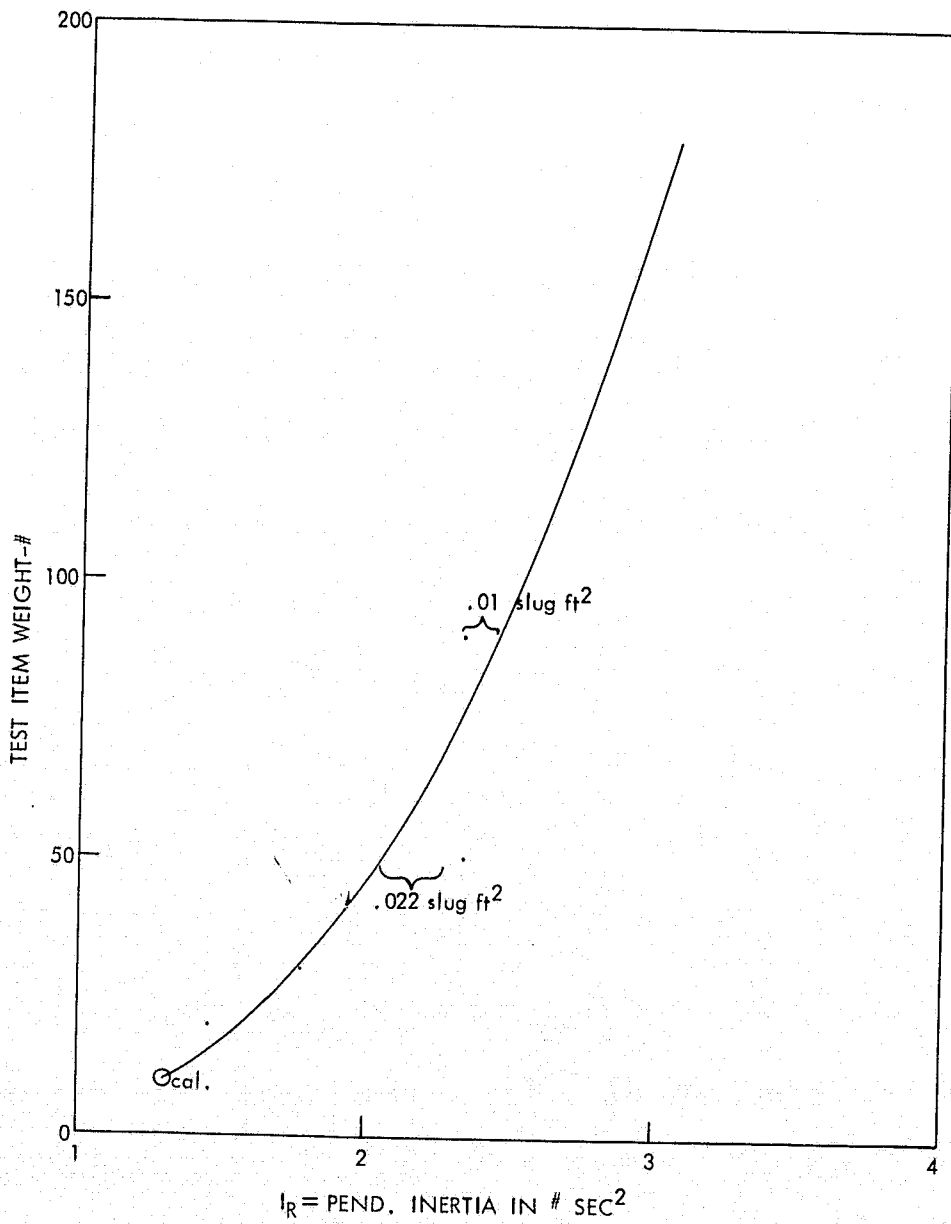
Torsion Locking Bars



Pendulum Bearing Assembly



Strength of Rod Check



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 300
EWT P.E.
FTM S.H.
RCB B.H.

Name of Test: Moments of Inertia S-3B

Date of Test: 12 Oct. 62

Requested by: E. W. Travis

Performed by: J. Kauffman, D. Bowers, T. Pierro

Purpose of Test:

Determine I of S-3 B with paddles folded and paddles open.

Description of Article Tested (Photographs, if any):

S-3 B flight unit

Test Equipment (Photographs, if any):

Standard moment of inertia torsion rod and calibrated disc.

Test Procedure:

Results

A. Paddles Open	50 cycles	3 min. 53.8 sec.
		3 min. 53.8 sec.
		3 min. 53.6 sec.
		3 min. 53.8 sec.
B. Paddles Closed	50 cycles	2 min. 27.4 sec.
		2 min. 27.4 sec.
		2 min. 27.2 sec.
		2 min. 27.4 sec.
C. Calibration		
without plate and clamp	51.6 seconds/50 cycles	
with plate and clamp	52.6 seconds/50 cycles	

I calibration disc = 0.264 slug-ft²

Results:

Paddles open 50 cycles = 233.8 sec.

$$I = 0.264 (233.8/51.6)^2 = .0103$$

$$I = 5.4096 \text{ slug-ft}^2$$

Conclusions:

Paddles folded

50 cycles = 147.4 sec.

$$I = 0.264 (147.4/51.6)^2 - .0103$$

$$I = 2.144 \text{ slug-ft}^2$$

I expended x-248 = 0.732 slug-ft² per DAC

$$2.144 + 0.732 = \boxed{2.876 \text{ Total}} \\ \text{slug-ft}^2 \text{ to de-spin}$$

E. W. Travis

II - FUNCTIONAL RELIABILITY TESTS S-3

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 1500-4

E.T. P.E.

JM S.H.

FTM B.H.

1/10/63

Name of Test: Timer Actuation S-3B

Date of Test: 9 Nov. 62

Requested by: E. W. Travis

Performed by: J. N. Kauffman

Purpose of Test: Check switch closure of serb timer vs. time at ambient (23°C) and 75°C temperature.

Description of Article Tested (Photographs, if any):

Raymond timer No. 1060 - 3-1/4 to 4-1/4 G's

Test Equipment (Photographs, if any):

1. Blue 'M' oven
2. Stop watch
3. Vom multimeter

Procedure

Prior to test runs 1-10

- A. Check switches for N.C. and N.O. (see diagram)
- B. Connect (1) Vom meter to pins 2 and 3
- C. Connect (1) Vom meter to pins 5 and 6
- D. When switches close Vom meter shows N.C. condition

Test Procedure:

- I. Make 5 runs at 23°C
 1. Actuate timer,
 2. Start stop-watch with meters connected to proper pins.
 3. Check switch closure (see diagram) and record time.
 4. Re-arm for next run.
- II. Make 5 runs at 75°C
 1. Same as I 1-4 procedure.

Results:

I At 23°C temp.

<u>Run No.</u>	<u>Time</u>
1	19 min. 57 sec.
2	20 min. 12 sec.
3	20 min. 7 sec.
4	20 min. 25 sec.
5	20 min. 10 sec.

II At 75°C temp.

<u>Run No.</u>	<u>Time</u>
6	20 min. 17 sec.
7	19 min. 58 sec.
8	19 min. 56 sec.
9	19 min. 50 sec.
10	19 min. 50 sec.

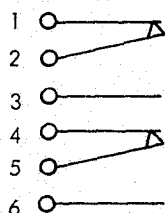
Note: Switch 5 and 6 closed 1 to 4 sec. later on the above runs.

Conclusions:

1. Timer operation was satisfactory at 75°C. Delay switch operation was also satisfactory.

E. W. Travis

PIN NO.



1 & 2 N.C.
2 & 3 N.O. - (CLOSE IN APPROX. 20 MIN.)
4 & 5 N.C.
5 & 6 N.O. CLOSE IN 1 to 4 SEC.

Raymond Timer No. 1060

JHK

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-18

TWF P.E.

HE S.H.

B B.H.

2/23

Name of Test: Vacuum test of 16-step digital motor

Date of Test: 8 Feb. 61

Requested by: T. W. Flatley

Performed by: R. H. Peterson

Purpose of Test: To determine the operating characteristics of the 16-step digital motor in a vacuum environment. (First test of the new design)

Description of Article Tested (Photographs, if any):

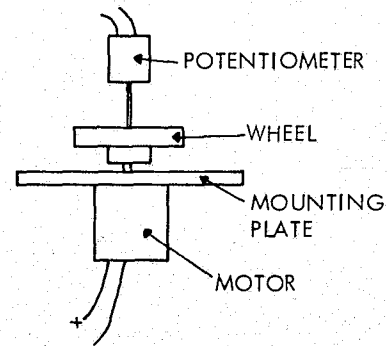
Basically a Curtiss-Wright DMA type digital motor, with internal modifications to convert it from 10 to 16 steps per revolution, driving a load which simulated the S-3 absorber wheel.

Test Equipment (Photographs, if any):

CVC vacuum system
Mechanical pulser
D.C. power supply
Sanborn recorder

Test Procedure:

1. Apply 27V pulses to the motor.
2. Monitor wheel position by means of a potentiometer and a sanborn recorder.



Results (Photographs and graphs, if any):

The unit performed satisfactorily for about 20 hours. It then began to skip steps occasionally and its performance became progressively worse. The trouble was found to be wear on the nylon cam which lifts anodized aluminum pawls to release the rotor prior to each step. The worn cam would not raise the pawls to the required position. Nylon pawls were substituted and the unit performance was improved somewhat although it was still not satisfactory.

Conclusions:

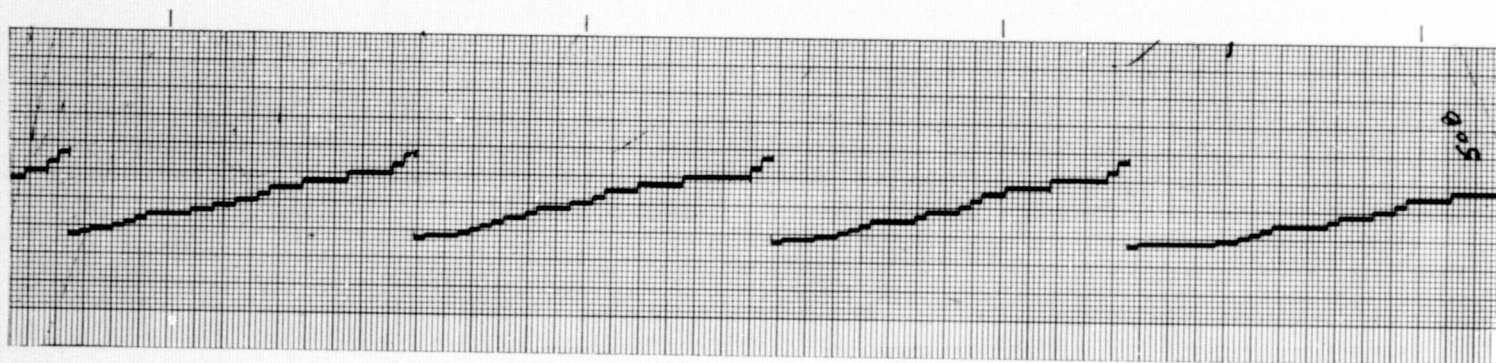
1. The initial satisfactory performance indicates that the redesign, converting the unit to 16 steps per revolution, did not introduce any additional problems in the motor performance.

2. The installation of a new cam and nylon pawls should eliminate the cam wear problem. Further study at this time is not planned due to the low priority of this work. This wear was one of the two main problem areas in previous testing of standard motors, the other being a spring fatigue problem.

Thomas W. Flatley



Sample: 16 Step Digital Motor — Operating Satisfactorily Most of the Time



Sample: 16 Step Digital Motor Operating Unsatisfactorily

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-19

TWF	P.E.
HE	S.H.
B	B.H.

2/23

Name of Test: Vacuum test of Haydon stepping device

Date of Test: 15 Feb. 61

Requested by: T. W. Flatley

Performed by: R. H. Peterson

Purpose of Test: To determine the operating characteristics of the Haydon stepping device, driving a load which is geared to 16 steps/revolution, in a vacuum environment.

Description of Article Tested (Photographs, if any):

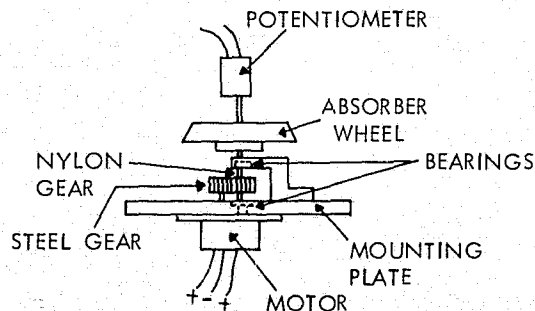
Haydon series 18100 stepper motor geared to a wheel which simulates the S-3 absorber wheel.

Test Equipment (Photographs, if any):

CVC vacuum system, dc Power Supply, Sanborn Recorder, Mechanical Pulser
D C power supply
Sanborn recorder
Mechanical pulser

Test Procedure:

1. Apply +27V volt pulses alternately to the two positive power leads
2. Monitor wheel position by means of a potentiometer and the Sanborn recorder.



Results (Photographs and graphs, if any):

Two tests were run. The first motor was disassembled and degreased, and the second was run as received from the factory. Pulse requirement according to the Haydon literature is 12.5 millisecc. With our test load, the unit would not operate with 100 millisecc pulses, but did operate with 300-700 millisecc pulses. The first unit failed due to mechanical interference inside the motor. Since crimping is used throughout the assembly, disassembly and re-assembly is difficult and damage to motor components is unavoidable. This unit ran well for about 8 hours, but its performance became increasingly worse after that. Signs of mechanical interference were evident on the rotor of the motor.

The second unit started off well but as the load increased, due to the drying of the lubricant in the vacuum, its performance also dropped off. It ran satisfactorily for about 4 hours.

No trouble was experienced in either test with the gearing or with the bearings which supported the wheel.

Conclusions:

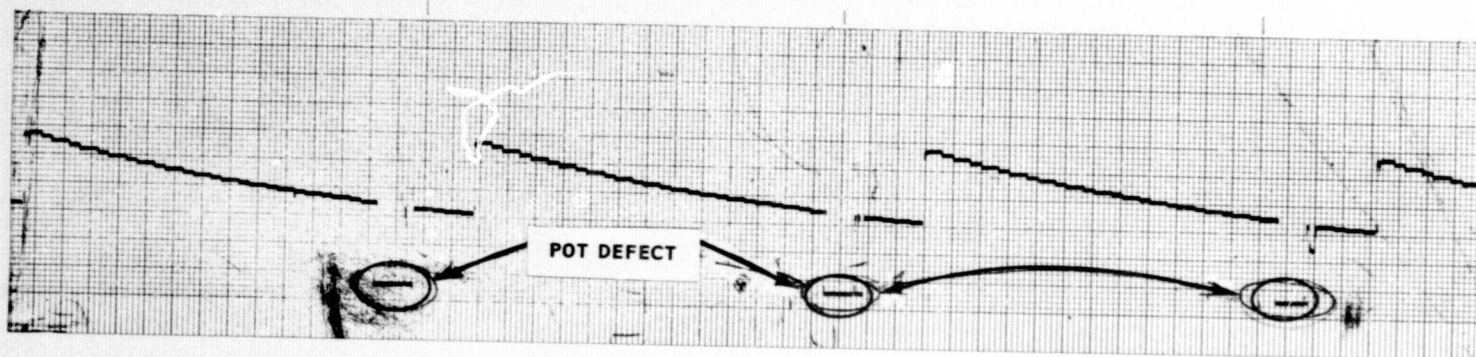
1. A unit built unlubricated at the factory which included bearing materials which will operate dry, would perform satisfactorily in a vacuum, under low load. Rework of standard units is impractical.

2. The electrical principle employed in the stepper seems inefficient. Power requirements of the motor increase greatly with increased mechanical load. The rated load is only 0.2 oz-in.

3. This unit was not considered acceptable as a drive unit for the S-3 absorber wheel, because of its magnetic characteristics and the complexity of the electronics required to provide the alternating pulses.

4. Further study of this motor will not be pursued.

Thomas W. Flatley



Sample: Haydon Stepper Motor Operating Satisfactorily



Sample: Haydon Stepper Motor Operating Satisfactorily

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-28

JM	P.E.
FTM	S.H.
B	B.H.

4/25

Name of Test: Vacuum Test, Timers

Date of Test: 1 April 61

Requested by: E. W. Travis

Performed by: Paul H. King

Purpose of Test: To determine if Timer will perform properly in a vacuum after being in vacuum for approx. ten minutes prior to actuation of timer.

Description of Article Tested (Photographs, if any):

S-3 Timer - see photographs

Test Equipment (Photographs, if any):

CVC Vacuum System.

Small angle aluminum jig with pulley arrangement for actuating timer.

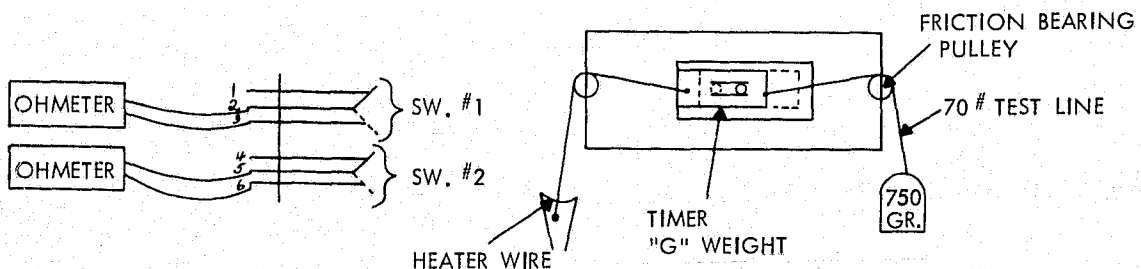
Temporary heater for cutting string.

Two Simpson Ohmmeters.

Two stop watches.

Test Procedure:

Placed timer mounted to jig into vacuum chamber. Brought vacuum to 10^{-4} and timed for 10 minutes. Vacuum reached 8×10^{-5} , cut string by means of heater to actuate timer. Recorded running time and closing of switches on test sheet. (Test sheet enclosed.)



Results (Photographs and graphs, if any):

From time of actuation, timer ran for twenty minutes, twenty nine and eight tenths seconds, switch #1 terminals number two and three closed. One and one half seconds later switch number two, terminals number five and six closed.

Conclusions:

Timer Serial No. 1

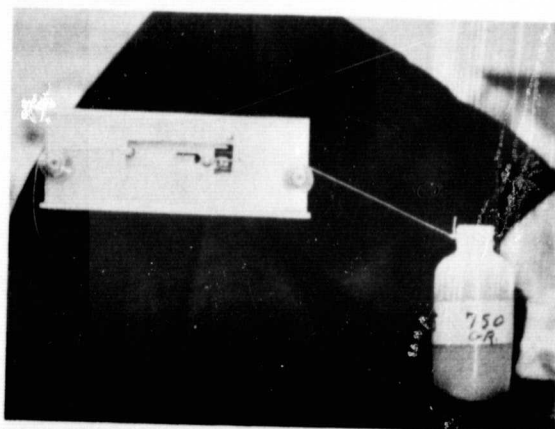
Timer mechanism performed within tolerance limits in a vacuum. (1200 seconds \pm 10%) specification

Switch No. 2 performed within its tolerance limit of 1 to 3 seconds after switch No. 1 closure.

Timer considered satisfactory for vacuum operation after 10 minutes vacuum soak.

E. W. Travis

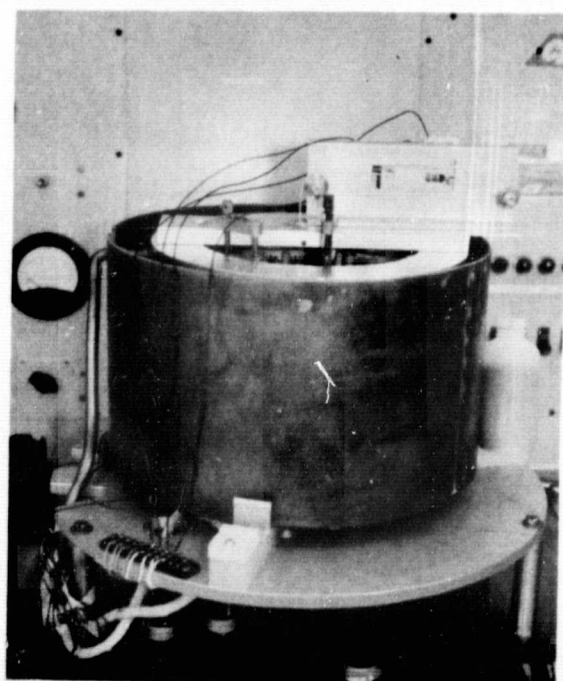
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S-3 Timer



S-3 Timer



S-3 Timer

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 300-35
JM P.E.
FTM S.H.
RCB B.H.

Name of Test: Determination of performance of shutter actuating mechanism.

Date of Test: 16 Feb. 60 to 18 Feb. 60

Performed by: R. Berkley and R. Peterson

Purpose of Test: The purposes of the test were to: (1) Determine if one small squib provides sufficient power for the mechanism; (2) See if "O" rings can seal the unit; (3) See if squibs will fire in vacuum.

Description of Article Tested (Photographs, if any):

The mechanism tested is illustrated in Figure 1. The action of the mechanism is the retraction of the piston due to gas pressure.

Test Equipment (Photographs, if any):

The mechanical systems branch vacuum chamber was used for part of the test.

Test Procedure:

Table I gives the test procedure with the exception of three squibs fired independently of the mechanism. These squibs had been in a vacuum of 0.03 microns for ten hours prior to firing. The weight on the piston referred to Table I was a weight hung on the piston perpendicular to its axis to simulate the shutter load.

Results (Photographs and graphs, if any):

All squibs used in the test ignited when connected to a three volt battery. Every time a squib was ignited in the mechanism the piston retracted and remained retracted until the gas was released. No damage to any of the parts was observed.

Conclusions:

The test showed that one small squib provides sufficient power to retract the piston under load.

The "O" rings used sealed the unit satisfactorily, i.e., the piston remained retracted and no gas was detected leaving the unit for a period up to one hour.

All four squibs placed in the vacuum ignited. Although further testing may be required, this test gives a strong indication that little or no difficulties will be encountered.

H. J. Cornille

TABLE I

Shutter Actuation Mechanism Test Program

Firing No.	No. of Squibs		Ambient Pressure	Weight on Piston
	Side 1	Side 2		
1	1	0	one atm.	2#
2	2	0	one atm.	2#
3	1	1	one atm.	2#
4	1	0	one atm.	3#
5	1	0	one atm.	3#
6	1	0	*0.3 microns	2#

*Was at this pressure for 10 hrs. before firing.

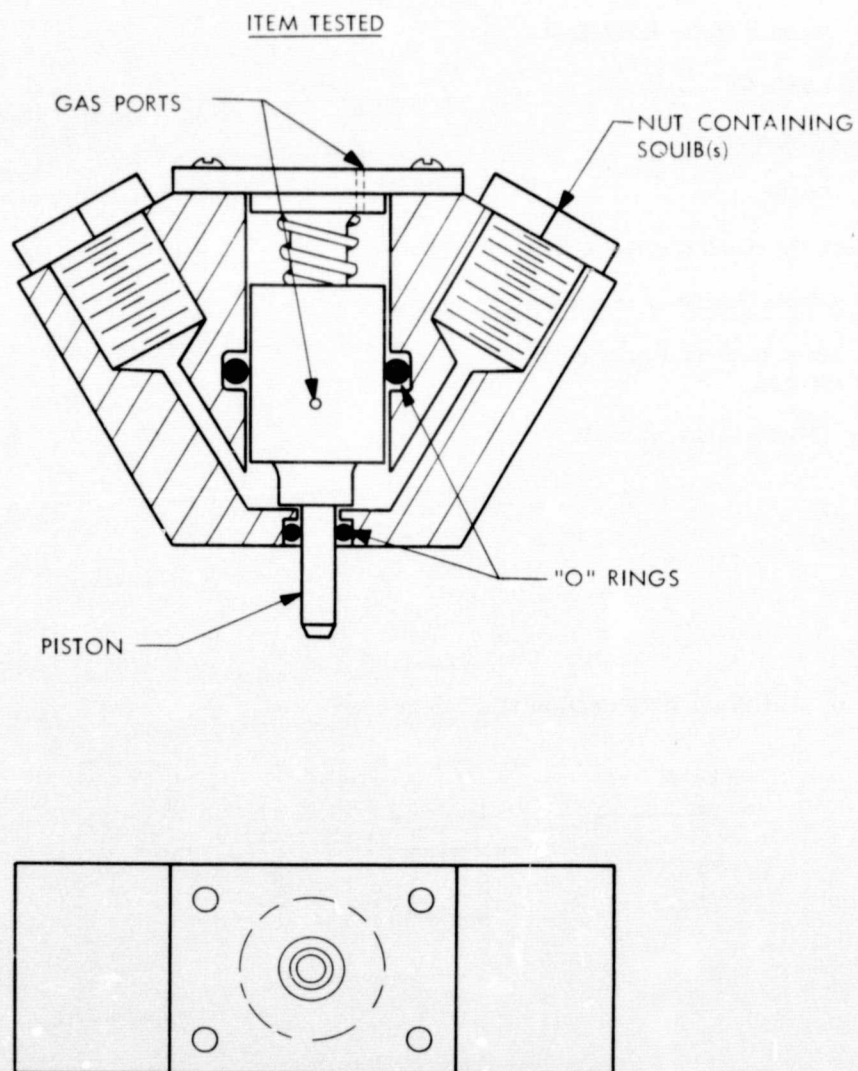


Figure 1

III - ACCEPTANCE TESTS S-3 AND S-3B

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-21

JM	P.E.
FTM	S.H.
RCB	B.H.

INFORMAL TEST REPORT

Name of Test: Antenna Static Load Test

Date of Test: 24 Feb. 61

Requested by: J. Madey

Performed by: Sween

Purpose of Test: To check for T-6 condition

Description of Article Tested (Photographs, if any):

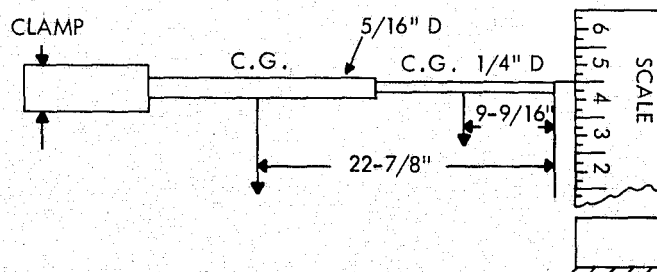
29" long antenna (standard vanguard)
Cobenium springs.

Test Equipment (Photographs, if any):

2 Rods
Surface plate
2 weight pans
Weights
Scale

Test Procedure:

1. Center of gravity for each section was determined



2. A 60 "g" load was applied at C.G. of each section. (60 × weight of each section).
3. Load was released and if set was intolerable antenna was reheated-treated.

Results:

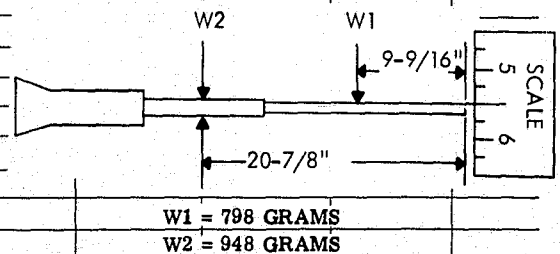
• Data sheet

Conclusions:

S-3 ANTENNA LOAD TEST STATIC

24 February 1961

Ant.#	"O"	Deflect.	Return	Set	Ant.#	"O"	Deflect.	Return	Set
M 3-1	1-13/16	6-3/16	1-15/16	1/8	44	1-25/32	6-1/32	1-25/32	0
M 3-2	1-5/8	6	1-3/4	1/8	45	1-15/16	6-5/16	1-3/32	1/32
M 3-3	1-11/16	6-1/16	1-13/16	1/8	46	1-13/16	6-1/8	1-7/8	1/16
M 3-4	1-3/4	6-1/8	1-7/8	1/8					
9	1-5/8	6-1/32	1-23/32	3/32					
10	1-7/8	6-1/4	1-15/16	1/16					
11	1-7/8	6-1/4	1-15/16	1/16					
12	1-9/16	6	1-15/16	1/16					
13	1-21/32	6-5/32	1-3/4	3/32					
14	1-5/8	6-1/8	1-23/32	3/32					
15	1-5/8	6-1/16	1-11/32	1/32					
16	1-9/16	6	1-5/8	1/16					
17	1-21/32	6-1/16	1-23/32	1/16					
18	1-5/8	6-3/32	1-3/4	1/8					
19	1-25/32	6-1/4	1-13/16	1/32					
20	1-9/16	6	1-11/16	1/8					
21	1-11/16	6-1/16	1-3/4	1/16					
22	1-5/8	6	1-21/32	1/32					
23	1-13/16	6	1-13/16	0					
24	1-3/4	6-1/16	1-3/4	0					
25	1-25/32	6-5/32	1-25/32	0					
26	1-9/16	6	1-19/32	1/32					
27	1-13/16	6-5/32	1-27/32	1/32					
28	1-13/16	6-1/8	1-27/32	1/32					
29	1-3/4	6-1/16	1-25/32	1/32					
30	1-13/16	6-1/4	1-27/32	1/32					
31	1-5/8	5-7/8	1-21/32	1/32					
32	1-11/16	6	1-11/16	0					
33	1-3/4	5-15/16	1-3/4	0					
34	1-3/4	6-1/16	1-25/32	1/32					
35	1-3/4	6-1/16	1-3/4	0					
36	1-3/4	6-1/16	1-25/32	1/32					
37	1-5/8	6	1-11/16	1/16					
38	1-3/4	6	1-3/4	0					
39	1-3/4	6-1/32	1-25/32	1/32					
40	1-13/16	6-1/16	1-7/8	1/32					
41	1-27/32	6-1/8	1-27/32	0					
42	1-3/4	6	1-3/4	0					
43	1-9/16	5-15/16	1-9/16	0					



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-10

JM	P.E.
FTM	S.H.
RCB	B.H.

INFORMAL TEST REPORT

Name of Test: Antenna Static Load Test

Date of Test: 27 Dec. 60

Requested by: J. Madey

Performed by: Peterson, King

Purpose of Test: To check for T-6 condition

Description of Article Tested (Photographs, if any):

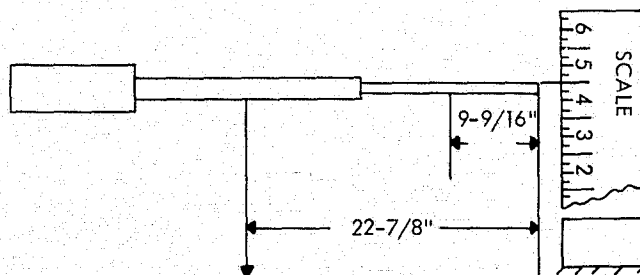
29" long antenna (standard vanguard)
Cobenium springs

Test Equipment (Photographs, if any):

2 rods
Surface plate
2 weight pans
Weights
Scale

Test Procedure:

1. Center of gravity of each section was determined.



$5/16"$ D = 15.75 grams

$1/4"$ D = 13.3 grams

2. A 60 g load was applied at C.G. of each section. ($60 \times$ weight of each section).
3. Load was released and if set was intolerable antenna was heat treated.

Results:

Data sheet

Conclusions:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 1500-2
P.E.
S.H.
RCB B.H.
10/15

Name of Test: Thermal Vacuum (Optical Aspect Electronics) S-3B

Date of Test: 10 Oct. 62

Requested by: R. C. Baumann

Performed by: Bush, Fash, Peterson

Purpose of Test: Acceptance test of optical aspect electronics card 11-03-0

Description of Article Tested (Photographs, if any):

Optical aspect electronics card #11-03-0

Test Equipment (Photographs, if any):

CVC system
Temperature recorder
Heat lamps

Test Procedure:

The card was sandwiched between two 1/4" aluminum plates and mounted on top of the refrigeration unit in the CVC vacuum system.

The system was pumped to as high a vacuum as possible (10^{-4} range).

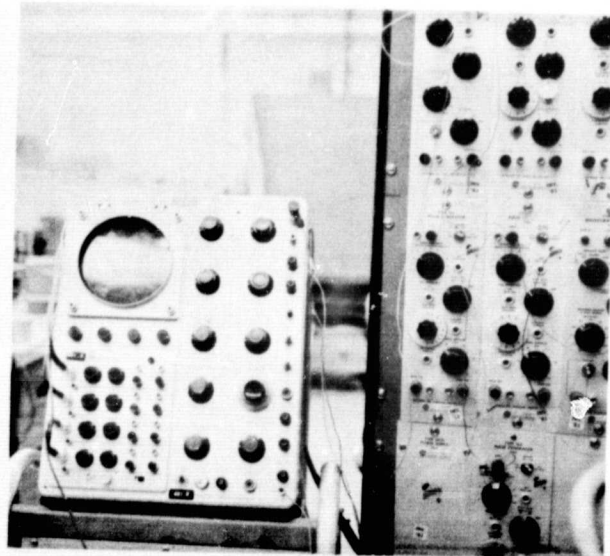
Temperature was lowered to 0°C and held for 9-1/2 hrs.

Temperature was raised to 40°C and held for 8 hrs.

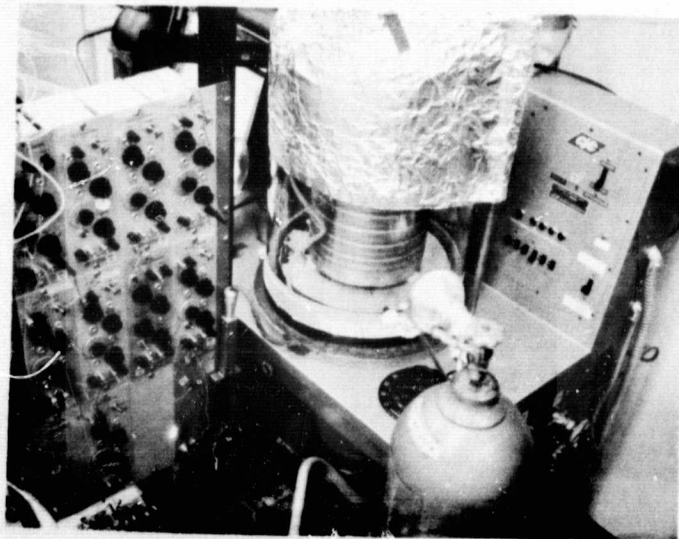
The electronics were operated during the entire time.

Results:

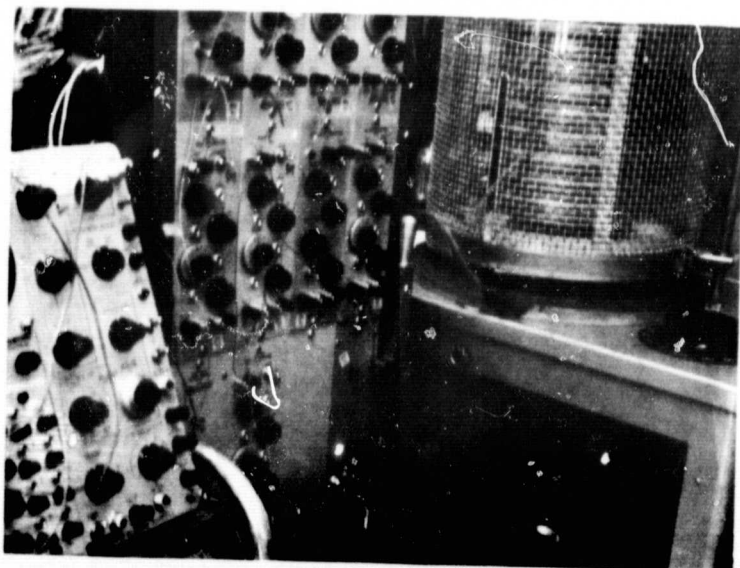
Conclusions:



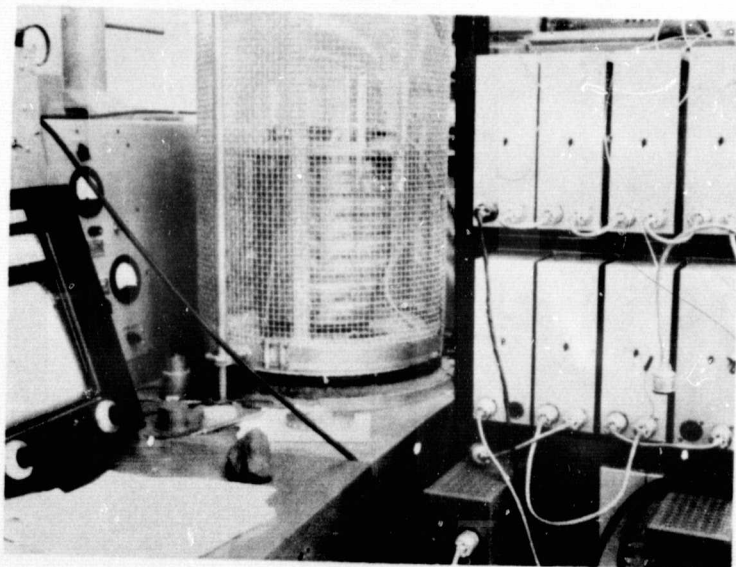
Instrumentation for Test



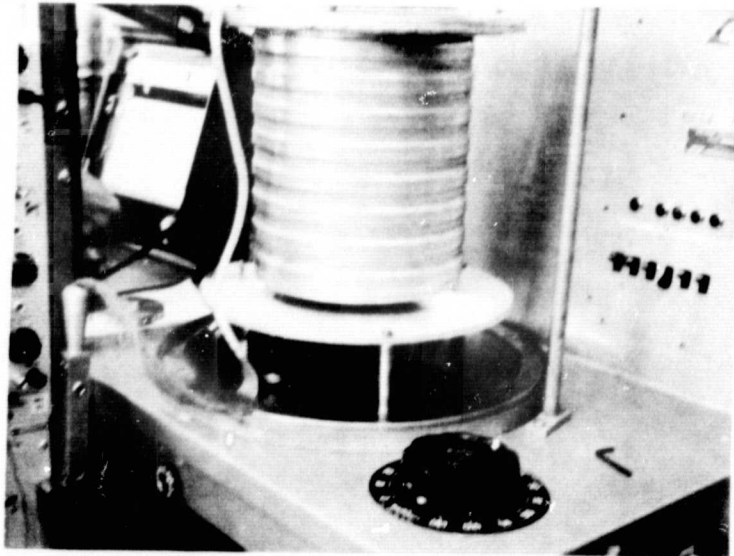
Test Set-up and Instrumentation



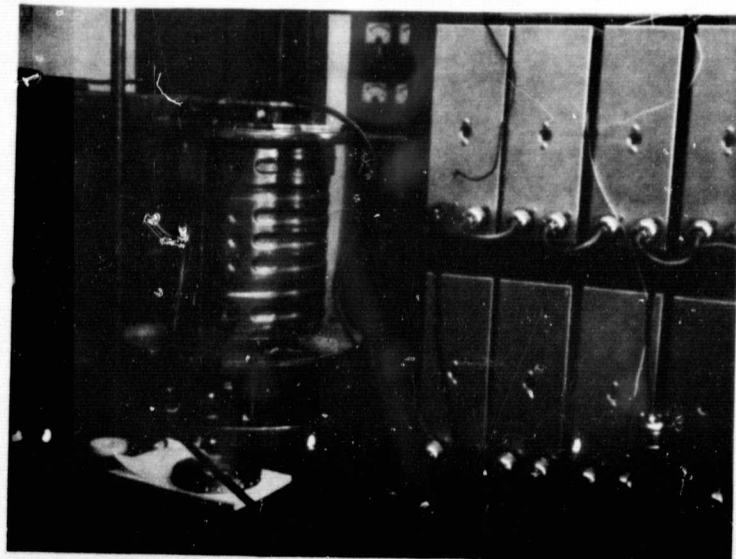
Test Set-up



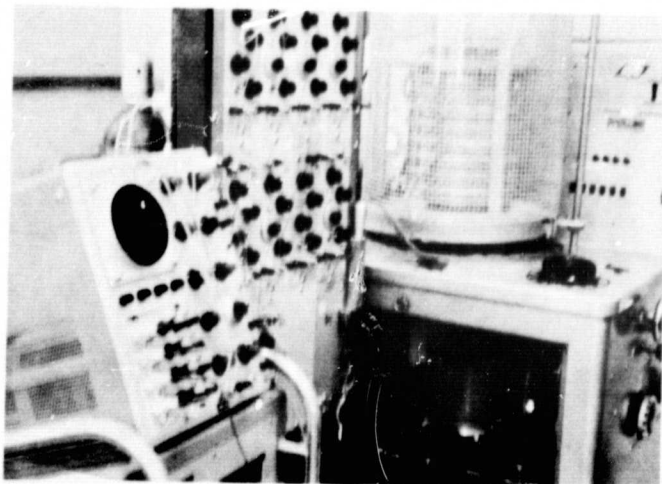
Test Set-up



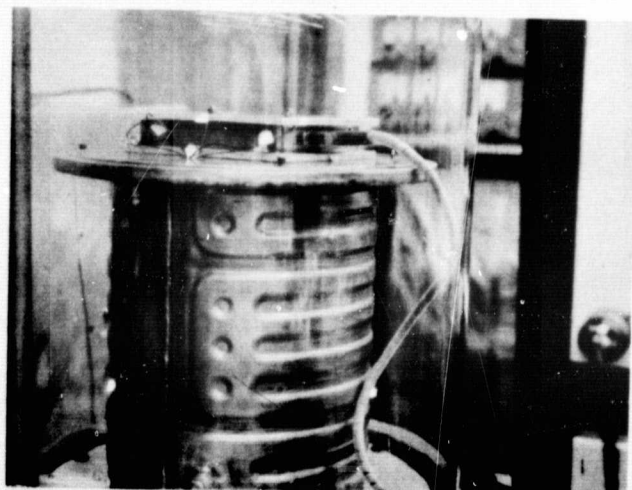
Test Set-up



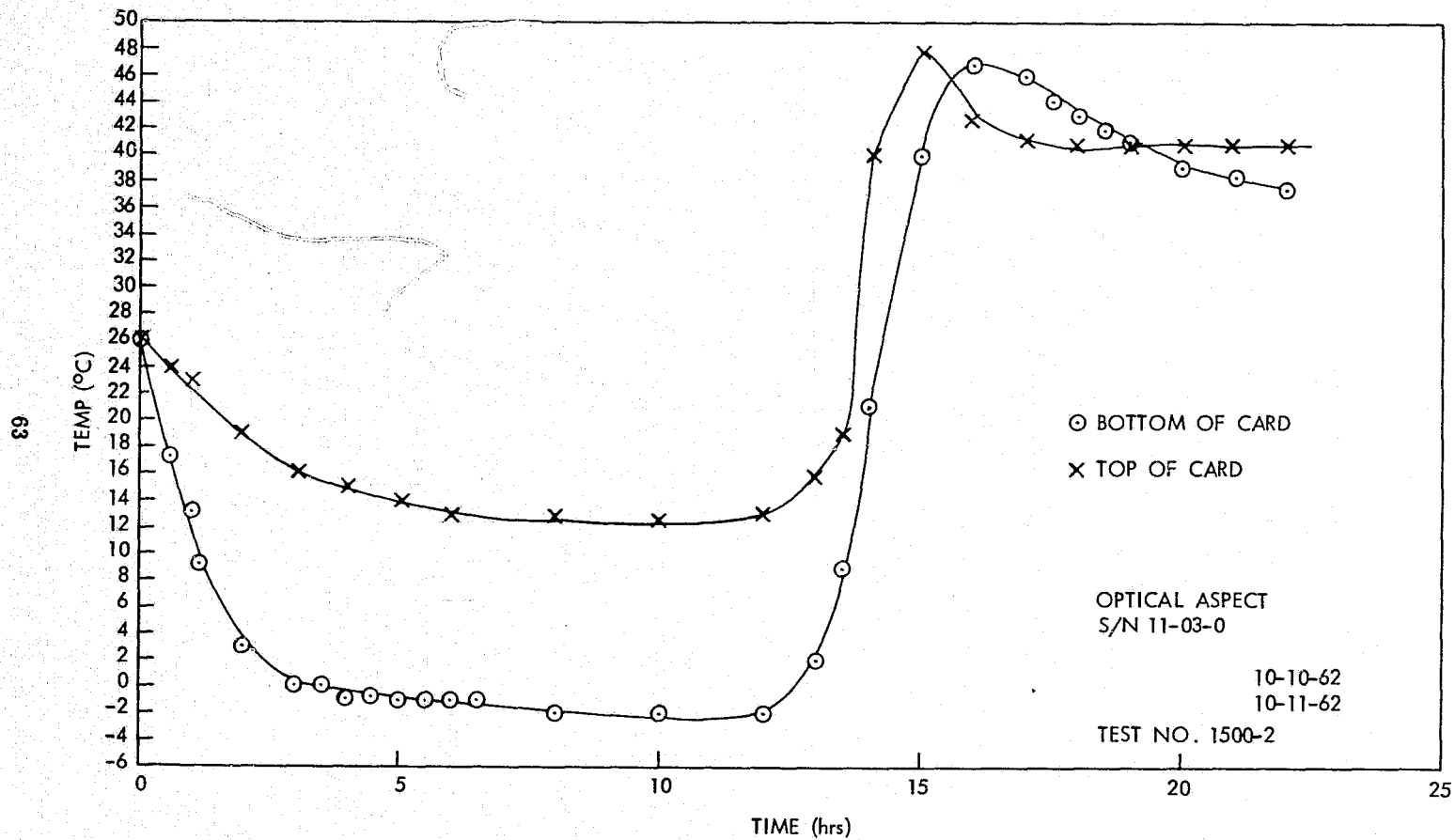
Test Set-up



Instrumentation



Test Set-up



SOLAR ASPECT CARD

10/10/62

COPPER CONSTANTAN - ICE REF. JUNCTION

Time	#1	#2	#3	#4	#5	#7	Pmm Hq
1800=0							
1840 .6	.67 17°C	.70 18°C	.70 18°C	.92 24°C	.92 24°C	.92 24°C	
1857 1	.51 13	.55 14	.55 14	.86 22	.88 23	.91 23	3.7×10^{-4}
1915 1.2	.34 9	.42 11	.42 11	.84 21	.84 21	.87 22	2.8×10^{-4}
2000 2	.12 3	.21 5	.20 5	.75 19	.75 19	.77 19	1.9×10^{-4}
2030 2.5	.05 1	.15 4	.14 4	.68 17	.68 17	.7 18	1.5×10^{-4}
2100 3	.05 -1	.05 1	.06 2	.63 16	.63 16	.64 16	1.5×10^{-4}
2130 3.5	.05 -1	.05 1	.06 2	.63 16	.63 16	.63 16	1.3×10^{-4}
2200 4	-.07 -2	.04 1	.05 2	.62 16	.58 15	.60 15	1.2×10^{-4}
2213 4.2	Turned off Refrig. to raise temp.						
2230 4.5	-.07 -2	.03 1	.04 1	.60 15	.58 15	.58 15	1.1×10^{-4}
2252	Refrig. Turned On						
2300 5	-.06 -2	.05 1	.06 2	.60 15	.54 14	.54 14	9×10^{-5}
2330 5.5	-.05 -1	.05 1	.06 2	.59 15	.52 13	.52 13	8×10^{-5}
2400 6	-.01 -1	0 0	0 0	.51 13	.5 13	.52 13	8.9×10^{-5}
0030 6.5	-1	0	0	13	13	13	8.9×10^{-5}
0100 7							

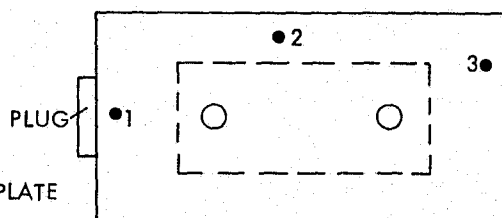
Time	#2	#3	#4	#5	#6	#8	Pmm Hq
1800=0							
0150 8	.15 -4	0		13	.5 13	.5 13	8.2×10^{-5}
0203 9.5	Temperature Stable						.47
0400 10	.175 -4	.05 -1	-.05 -1	.5 13	.5 13	13	7.5×10^{-5}
0500 11	Stable						
0600 12	-4	-1	-1	13	13	13	7×10^{-5}
0630 12.5	-.1 -3	.05 1	.05 1	.625 16	.6 15	.55 14	8×10^{-5}
0700 13	1	.2 5	.15 4	.7 18	.65 16	.6 15	9.9×10^{-5}
0730 13.5	.2 5	.37 9.5	.32 9	.8 20	.75 19	.67 17	1.1×10^{-4}
0800 14	18.5	25	23	37	40	37	2.2×10^{-4}
0855 15	38.5	42.5	40	47	48	45.5	3.8×10^{-4}
0940 15.6	1.92 47	1.92 47	1.88 46	1.80 44	1.80 44	1.76 44	4×10^{-4}
1000 16	NG	1.93 47	1.93 47	NG	1.74 43	1.74 43	3.8×10^{-4}
1030 16.5	NG	1.90 47	1.90 47	NG	1.70 42	1.70 42	3.4×10^{-4}
1100 17	NG	1.82 45	1.85 46	NG	1.66 41	1.68 41	2.8×10^{-4}
1130 17.5		1.78 44	1.80 44		1.65 41	1.67 41	2.5×10^{-4}
1200 18		1.72 43	1.74 43		1.64 41	1.66 41	2.1×10^{-4}
1230 18.5		1.68 42	1.70 42		1.67 41	1.64 41	
1305 19		1.63 41	1.64 41		1.63 41	1.65 41	1.7×10^{-4}
1400 20		1.58 39	1.58 39		1.63 41	1.65 41	1.3×10^{-4}
1515 21.2		1.56 39	1.52 38		1.59 39	1.62 41	1.1×10^{-4}
1610 22.2		1.48	1.48		1.57	1.61	
1615	Test Terminated - Test Stand Required						

OPTICAL ASPECT CARD
CVC SYSTEM

THERMOCOUPLE LOCATION

BOTTOM PLATE

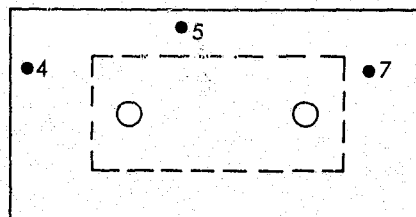
TC ON TOP OF PLATE



LOOKING DOWN

TOP PLATE

TC UNDER PLATE



LOOKING DOWN

0150

PRINT WHEEL ADVANCED ONE NUMBER.

IV - COMPONENT AND STRUCTURAL INTEGRITY S-3

File No. 300-3

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

JM P.E.
FTM S.H.
RCB B.H.

INFORMAL TEST REPORT

Name of Test: Solar Cell Module Deflection and Strain Test

Date of Test: 11 Aug. 60

Requested by: J. Madey

Performed by: Kauffman and F. Le Doux

Purpose of Test: To obtain a deflection vs load curve as well as a strain reading at critical locations for use in evaluating future deliveries of modules and also in the event that redesign of the module would be required for the S-3A. satellite.

Description of Article Tested (Photographs, if any):

Solar cell module
Photos. No. 1 and 2

Test Equipment (Photographs, if any):

Dial indicators (.0001")
SR-4 strain indicator
Photo. No. 3

Test Procedure:

1. Install strain gages as per sketch.
2. Load in 1# increments to 10# at tip and record deflection at three positions and strain in microinches per inch.

Results:

Plot of deflection vs. load.
Plot of strain vs. load.

Conclusions:

The present module will take a 10# load applied at the tip without failure of structure.

1. Strain gage was attached to outer skin (.0037" A_L 5052-H38). Yield strength = 37,000 psi
2. Stress for a 10# load is:

$$E = S/\epsilon$$
$$S = 10,200 \text{ psi}$$

3. Calculated stress for concentrated load on cantilever beam is:

$$S = M/t_c t_f$$
$$t_c = \text{Core Thickness} = 1.062$$
$$t_f = \text{Facing Thickness} = .0037$$
$$S = 12,800 \text{ psi}$$

S-3 SOLAR CELL MODULE WITHOUT DIAL INDICATORS

11 August 1960

G.F. = 2.00

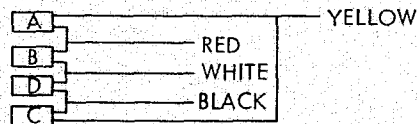
[illegible]

S-3 SOLAR CELL MODULE

12 August 1960

G.F. = 2.00

Load	1	2	3	Min./In.	Thousand Range		
0	0	0	0	550	10		
1	.0070	.0028	.0003	970			
2	.0150	.0068	.0014	1375			
3	.0239	.0101	.0024	1800			
4	.0316	.0159	.0031	195	12		
5	.0391	.0178	.0042	610			
6	.0468	.0212	.0051	1020			
7	.0550	.0251	.0061	1440			
8	.0626	.0287	.0070	1850			
9	.0702	.0322	.0079	250	14		
10	.0800	.0367	.0093	710			
0	.0021	.0011	.0004	610	Before Shake		
	.0006	.0003	-.0002	560	After Shake		
0	0	0	0	570	10		
1	.0068	.0028	.0004	950			
2	.0146	.0065	.0015	1370			
3	.0231	.0106	.0025	1800			
4	.0304	.0138	.0034	195	12		
5	.0380	.0173	.0044	610			
6	.0459	.0211	.0054	1025			
7	.0556	.0252	.0064	1460			
8	.0622	.0285	.0075	1870			
9	.0695	.0321	.0082	280	14		
10	.0772	.0352	.0091	680			
0	.0008	.0004	.0004	600	Before Shake		
	.0002	-.0002	.0000	585	After Shake		
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							



A & D TOP GAGES
B & C BOTTOM GAGES

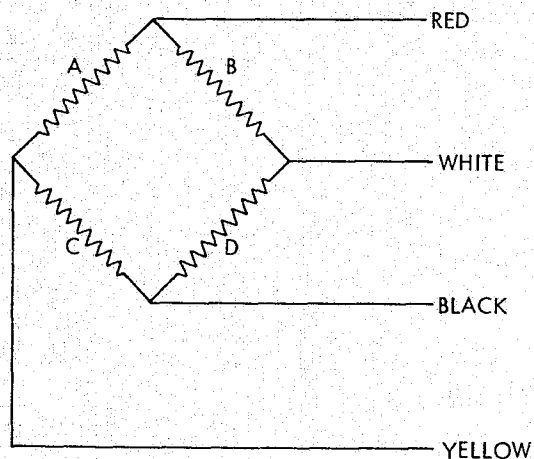
120 Ω PAPER STRAIN GAGES

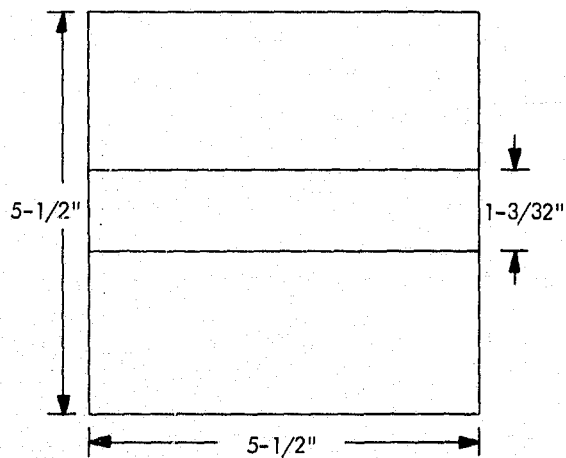
S-3 SOLAR CELL MODULE
STRAIN GAGE BRIDGE.

NOTE: RED & BLACK POWER OR COMP.
WHITE & YELLOW POWER OR COMP.

MUST BE USED AS PAIRS

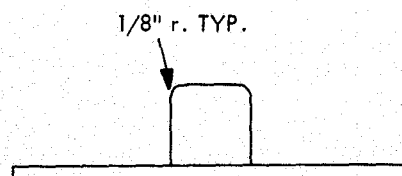
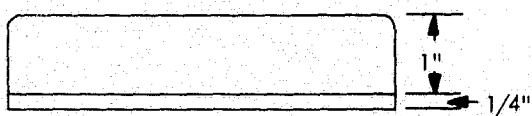
70

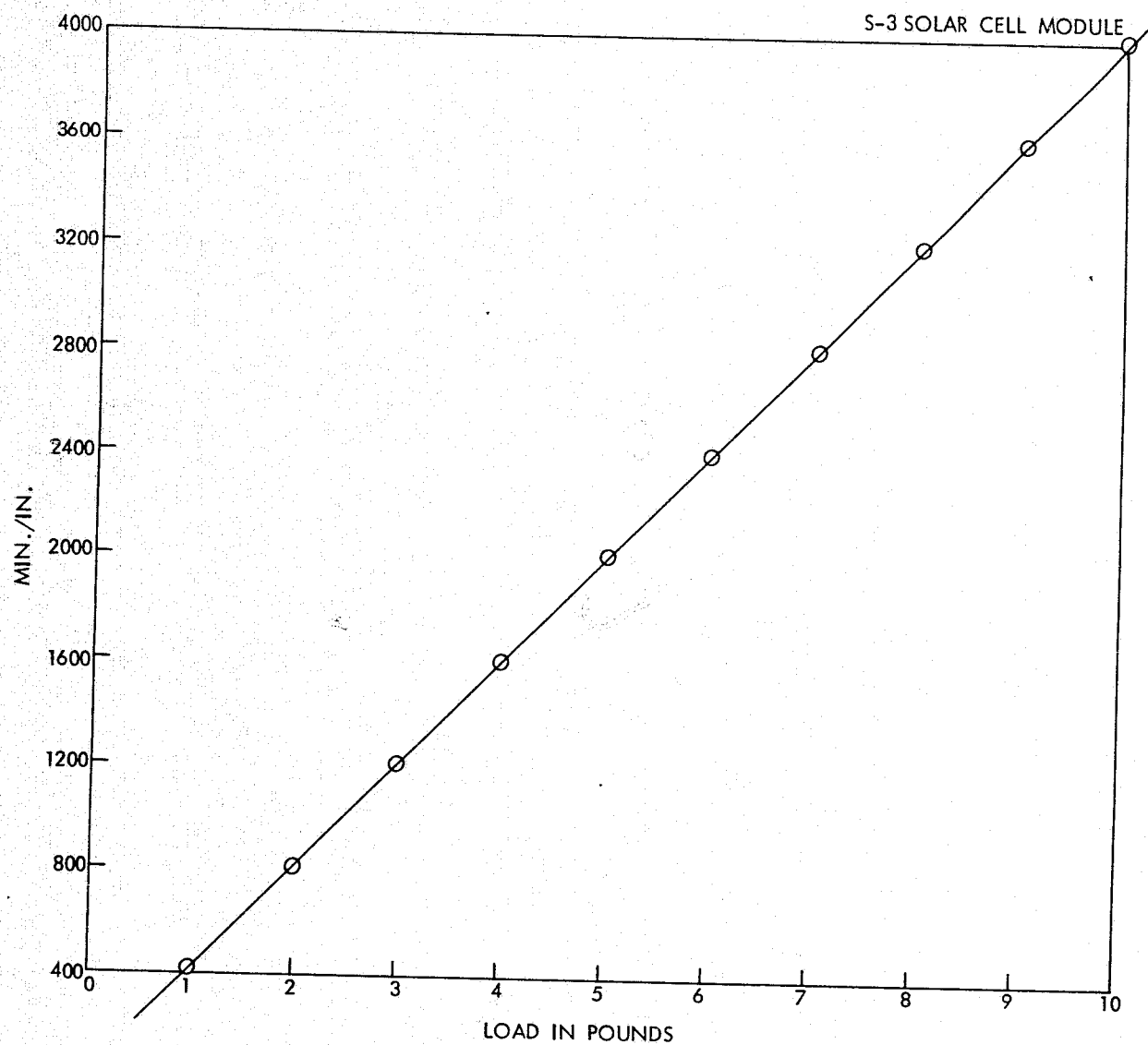


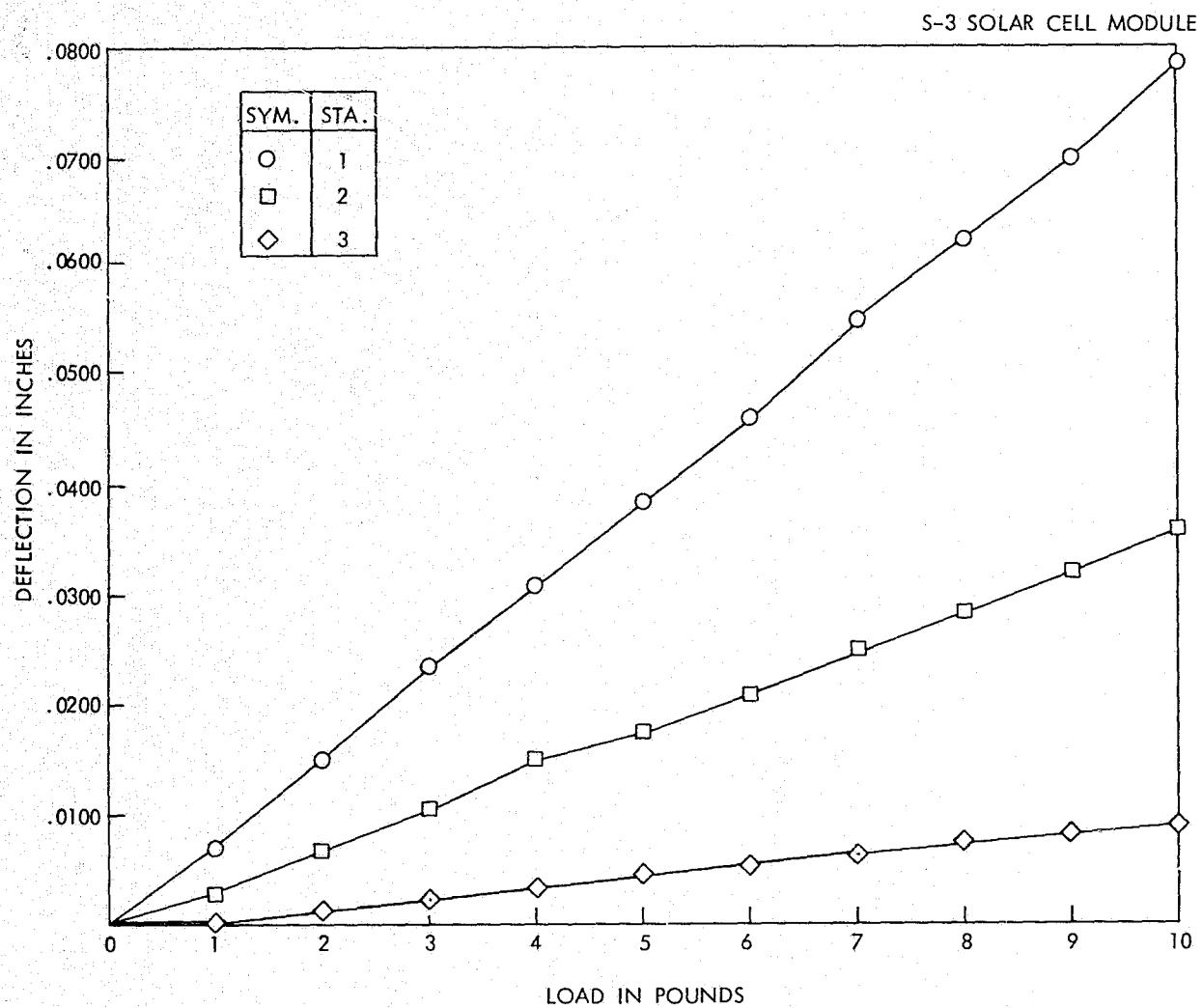


TEST FIXTURE
S-3 SOLAR CELL MODULE

1 REQ'D
MAT'L: ALUM.

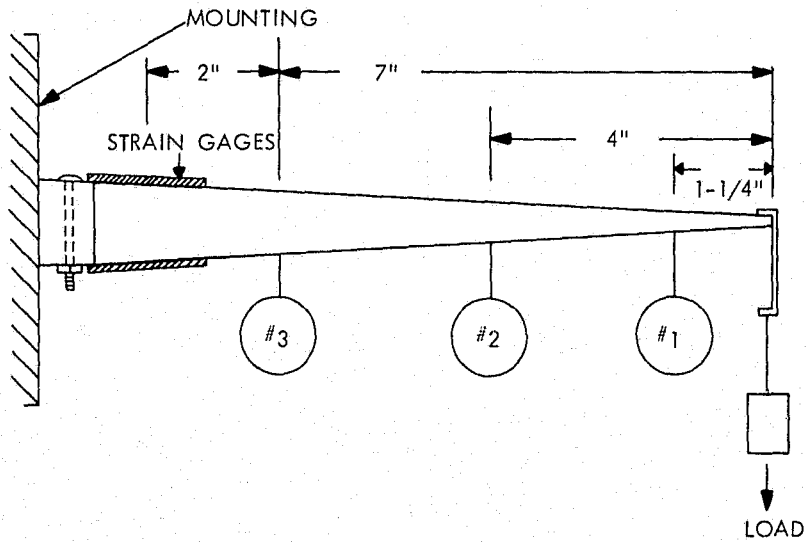


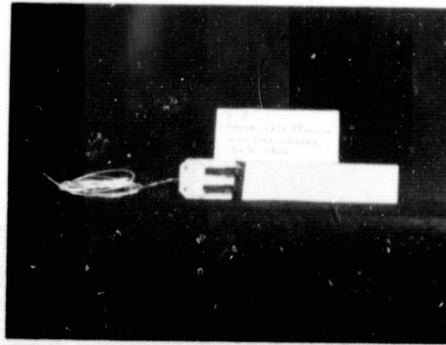




S-3 SOLAR CELL MODULE

DIAL INDICATOR STATIONS

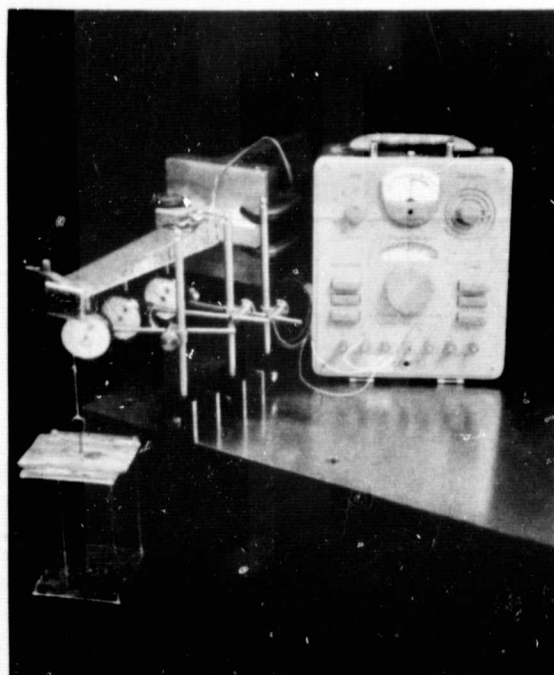




Solar Cell Module



Solar Cell Module



Instrumentation and Set-up

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-15

JM	P.E.
FM	S.H.
RB	B.H.

INFORMAL TEST REPORT

Name of Test: Load Test, Moment of Inertia Rods

Date of Test: 20 Feb. 61

Requested by: E. W. Travis

Performed by: D. Corbin

Purpose of Test: To determine the structural integrity of a joint when 1) welded, 2) silver soldered

Description of Article Tested (Photographs, if any):

Test article No. 1.

4' long, .250 dia. steel rod with rectangular steel blocks (1/2" x 3/4" x 2") welded to each end.

Test article No. 2.

4' long, .250 dia. steel rod with rectangular steel blocks (7/8" x 1-1/2" x 2") silver soldered to each end.

Test Equipment (Photographs, if any):

Weight pan	10 lbs.
Dead weights	469 lbs.

Test Procedure:

Test No. 1

Rod with the blocks welded to each end was affixed to the moment of inertia test fixture. A cable was affixed to the block on the free end. A weight pan was suspended from the cable. Dead weights were then loaded on the weight pan in increments of 10 pounds each. After each increment of load inspection was made of the welded portions of rod and blocks. The maximum load applied was 480 pounds. Maximum load was maintained for a period of fifteen minutes.

Test No. 2

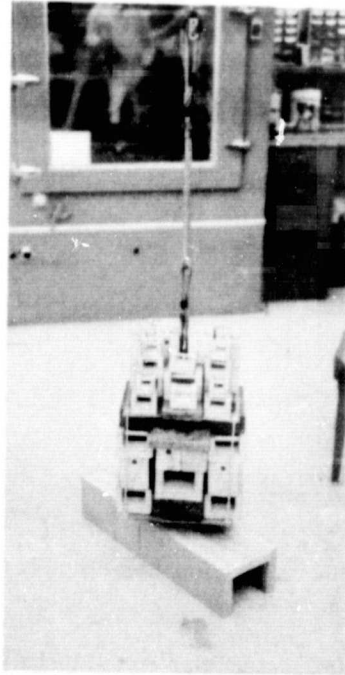
Test No. 2 was conducted in the same manner as Test No. 1 using test article No. 2.

Results:

No apparent damage to weld or connection of blocks and rod were noted.

Conclusions:

It was determined that blocks welded or silver soldered to moment of inertia rods were adequate to support the S-3 satellite.



Test Set-Up



Test Set-up

1. 100-10
 2. 100-10
 3. 100-10
 4. 100-10
 5. 100-10

MECHANICAL SYSTEMS LIBRARY AIRCRAFT INVESTIGATION AND SUPPORT FOR KEY DESIGN INTERNAL TEST REPORT

Name of Test: Erection Shock Test, Solenoid Pads

Date of Test: 22 Feb 61

Test Location: 1. 100-10

Personnel: H. Johnson, R. King, E. Taylor, J. Moore, T. Jackson

Purpose of Test: To determine the effect of the

Installation of Solenoid

Test Equipment: 1. 100-10

Test Results: 1. 100-10

Test Procedure: 1. 100-10

Test Results: 1. 100-10

Test Results: 1. 100-10

Test Results: 1. 100-10

Test Results: 1. 100-10

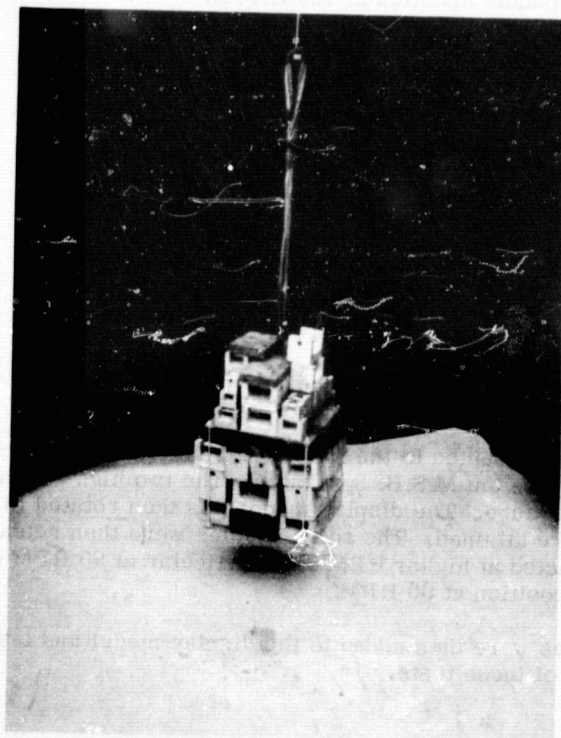
Test Results: 1. 100-10

Test Results: 1. 100-10

Test Results: 1. 100-10

Test Results: 1. 100-10

Test Results: 1. 100-10



Test Set-Up

The lower padlock locked into position. The upper or test padlock locked in
 at 50 RPM. Both the upper and lower padlocks locked and positioned at 50 RPM. It was noted
 that the speed at the time the padlocks were released.

Comments:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-20

<u>JM</u>	<u>P.E.</u>
<u>FM</u>	<u>S.H.</u>
<u>RB</u>	<u>B.H.</u>

INFORMAL TEST REPORT

Name of Test: Erection Shock Test, Solar Paddles

Date of Test: 25 Feb. 61

Requested by: J. Madey

Performed by: R. Peterson - P. King - E. Travis - J. Madey - F. LeDoux

Purpose of Test: To test paddle erection at 120 R.P.M.

Description of Article Tested (Photographs, if any):

Display model with simulated solar paddles

Test Equipment (Photographs, if any):

M.S.B. spin table
Stop watch
Strobatac 16 MM color movie camera
Polaroid camera

Test Procedure and Results:

Springs were removed from the simulated solar paddles.

The display model was mounted to the locating fixture (used to checkout paddle position), which in turn was mounted on the M.S.B. Spin table. The two high paddles were mounted and tied down to the locating fixture. The display model was then rotated in a counterclockwise position until 60 RPM were attained. The solar paddles were then released. They did not lock. Further tests were conducted at higher RPM's in particular at 90 RPM and 120 RPM. The high paddles locked into position at 90 RPM.

The two lower paddles were then added to the display model and testing continued. The following are the results of these tests.

Results:

The lower paddles locked into position at 60 RPM. The upper or high paddles locked in at 90 RPM. Both the upper and lower paddles locked into position at 90 RPM. It was noted that the speed of the spin table decayed rapidly after the paddles were released.

Francis LeDoux

Conclusions:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-24
F.L. P.E.
F.L. S.H.
B B.H.

INFORMAL TEST REPORT

Name of Test: Structural Integrity Honey Comb Material

Date of Test: 23 Nov. thru 30 Nov. 60

Requested by: F. LeDoux

Performed by: F. LeDoux (Peterson)

Purpose of Test: To determine structural integrity when subjected to environments as may be experienced during humidity and thermal vacuum tests by test groups.

Description of Article Tested (Photographs, if any):

- a. 3 inch square piece of honey comb.
- b. Photograph attached. (Taken after test).

Test Equipment (Photographs, if any):

- a. Water bath
- b. Consolidated vacuum system
- c. Honeywell temperature recorder

Test Procedure:

1. The test specimen was first inspected (visually) so as to determine any apparent flaws in the material. No flaws were apparent. The test specimen was then immersed into a shallow dish of tap water. It was necessary to place a weight of approximately three ozs. on top of the test specimen to hold it below the surface of the water. After an elapsed period of 120 hours the test specimen was removed and dried with a Scott towel.

2. The test specimen was then taped onto an aluminum fixture. A thermocouple was then placed on the face of the test specimen. The fixture with material attached was then placed into the consolidated vacuum chamber. The test specimen remained in the test chamber for a period of twenty three and one half hours. Appendix A attached is a true copy of data and reflects the actual time, temperature and pressures that the test specimen experienced.

Results: (Photographs and graphs, if any):

1. No apparent detrimental effects to the test specimen were noted due to immersion in water.
2. For reasons unknown at this time a separation of the face material from the honeycomb reinforcement occurred around the entire edge of the test specimen. This fact can be noted from the attached picture, as well as from the test specimen attached. Failure of test specimen carried back up to and including the third cell from edge.

N.B.

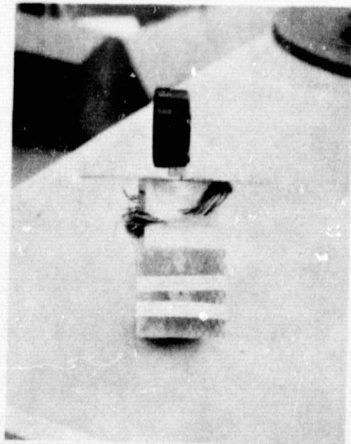
The outer edge of the test specimen was unprotected therefore a question arises as to what effects if any would be experienced on a protected edge.

Conclusions:

It is suggested that further study be given to determine exact results that may be expected when honeycomb material is subjected to the same environments for longer periods of time.

Tests should be conducted with specimens having edges protected (Hysol Epoxi) and specimens having unprotected edges.

Francis N. LeDoux



Test Specimen

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-34

JM P.E.

FTM S.H.

B B.H.

4/25

Name of Test: Vibration (Payload Integrity)

Date of Test: From: 30 March to 2 April

Requested by: J. Madey

Performed by: J. H. Conn (Vibration Section)

Purpose of Test: To determine payload integrity when subjected to a vibration environment.

Description of Article Tested (Photographs, if any):

S-3 prototype

Test Equipment (Photographs, if any):

MB - C 50 vibrator, sine and random capabilities horizontal facilities.

Test Procedure:

1. See attached sheets 3 & 4.
2. For location of accelerometers see page 101.
 - a. Accelerometer #1 mounted on inside of platform, above single crystal detector and next to (SUI) G. M. counter.
 - b. Accel. #5 mounted on power supply end (heavy section) of double S. telescope.
 - c. All other accel. mounted on underside of platform as shown on page 101.

Vibration

The procedures for conducting the vibration exposures shall be in accordance with the Delta Payloads Testing Procedures of Code 321.2 (page 16 of the appendix).

Prototype Qualification

Sinusoidal Vibration

Levels of exposure shall be in accordance with the following table:

Frequency Range (cps)	Vector Acceleration (g)	
	Thrust Axis	Transverse Axes
5-50	2.3	0.9 (a)
50-500	10.7	2.1
500-2000	21	4.2
2000-3000	54	17

NOTES:

- (a) Within maximum amplitude limit of vibration generator.
- (b) Within maximum frequency limit of vibration generator.
- (c) The sweep rate shall be two octaves per minute.
- (d) The duration of the exposure shall be approximately five minutes in each direction (total time - 15 minutes).

Random

Levels of exposure shall be in accordance with the following table for each of the three major axes:

Frequency Range (cps)	Spectral Density (g^2/cps)	Amplitude $g = \sqrt{\Delta f g^2/cps}$ (g-rms)	(a) Duration Min.
20-2000	.07	11.5	4.0

NOTES:

- (a) Four minutes each axis - total time: 12 minutes.
- (b) White Gaussian noise with g-peaks clipped at three times the rms acceleration

X-248 Combustion Resonance

Levels of exposure shall be in accordance with the following table:

Axis	Frequency	Force	Duration
Thrust	550-650 cps	(a) ± 600 pounds	30 seconds
Transverse Axes	550-650 cps	(a) ± 100 pounds	30 seconds

NOTES:

- (a) If it is not possible to program force with available equipment, the vector acceleration shall be determined by dividing ± 600 lbs. force (thrust axis) or ± 100 lbs. (transverse axes) by the apparent weight of the payload in pounds, as measured over the 550-650 cps range.
- (b) Each test is conducted by sweeping once at a rate so that 30 seconds are required to traverse the band from 550 cps to 650 cps.

Results: (Photographs and graphs, if any):

1. See data sheet (page 100)
2. Sine thrust Axis results (1st. sine sweep)
 - a. Screws on dummy paddles were loose but on the active paddle all screws were tight.
 - b. Approximately (8) eight screws loosened on lower cover.
 - c. Transmitter failed at 100 cps (vacuum tube failed)
 - d. Photo-multiplier in Ion-Detector failed
3. Repeat sine sweep (transmitter and Ion-Detector repaired)
 - a. Ames package developed intermittent-current drop.
4. G.M. Telescope was found inoperative after completion of thrust test.
5. Test was completed without any additional failures.

Conclusions:

1. Screws in the dummy paddles were not the specified special Ny-lock screws, that were used on the live paddle. These were replaced with Ny-locks without any additional failures.
2. The screws on the lower cover were assembled with orange lock-tite. This lock-tite is not as reliable as blue lock-tite. Orange was used to insure easier removal of screws and to minimize screw breakage. The flight unit will be assembled with either blue lock-tite or Ny-lock screws.
3. There were no visible failures (fractures, etc.) on the S-3 structure.

J. Madey

DATA

A. Thrust Axis

1. Sine Test:

Frequency	Input g's	Output g's	Location	Sensitive Axis of Accelerometer
105 cps	11.0	80	SUI Encoder	Thrust
105 cps	11.0	50	Pulse Analyser	Thrust
105 cps	11.0	80	Encoder	Thrust
105 cps	11.0	100	SUI Spectrometer	Thrust
105 cps	11.0	20	Double Telescope	Lateral
105 cps	11.0	40	Double Telescope	Thrust
105 cps	11.0	90	SUI Counter	Lateral
105 cps	11.0	80	Paddle 4	Lateral
230	11.0	65	Double Telescope	Lateral
230	11.0	80	Double Telescope	Thrust
105 cps	11.0	70	I & E Det.	Thrust
105 cps	11.0	25	G.M. Telescope	Thrust
200 cps	11.0	40	G.M. Telescope	Thrust
2800 cps	54.0	65	G.M. Telescope	Thrust

2. 600 Cycle test:

Frequency	Input g's	Output g's	Location	Sensitive Axis of Accelerometer
550-575 cps	56	200	Magnetometer	Thrust
The accelerometer fell off because of high g's at about 575 cycles.				

B. Axis II-IV Test

1. Sine test:

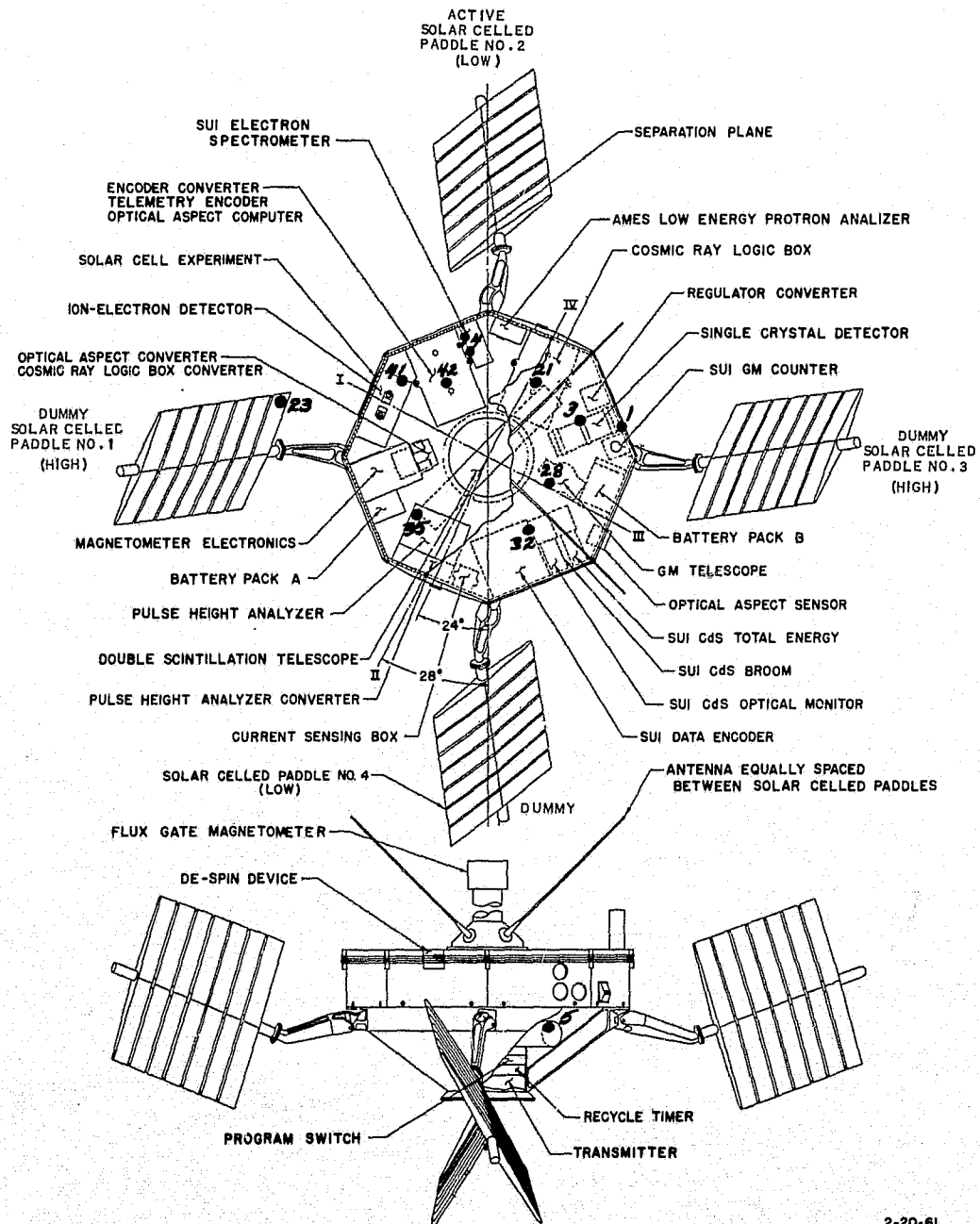
Frequency	Input g's	Output g's	Location	Sensitive Axis of Accelerometer
130 cps	2.1	26	Paddle 4	Lateral
56	2.1	20	Double Telescope	Lateral
56	2.1	25	Double Telescope	Thrust
180	2.1	19	SUI Encoder	Thrust

C. Axis I-II Test

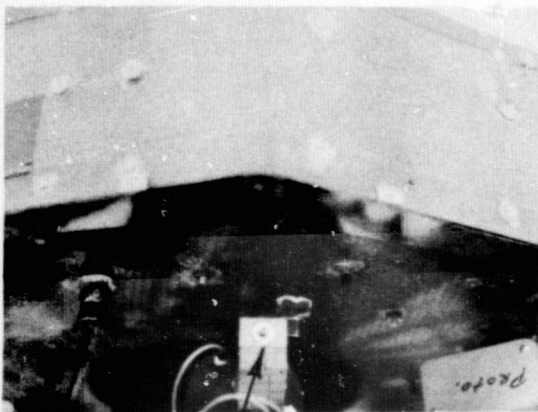
No Q's greater than 2.

*The data noted are those points which the Q's were significant.

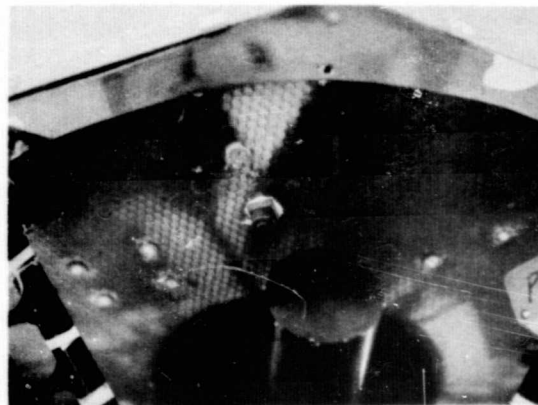
S-3 ENERGETIC PARTICLES SATELLITE



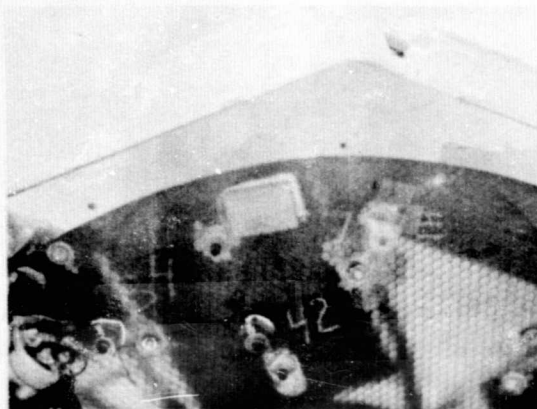
2-20-61



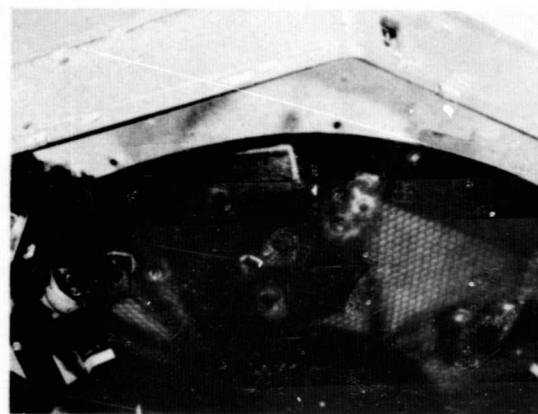
Double Telescope
#3 Single Crys. Det.



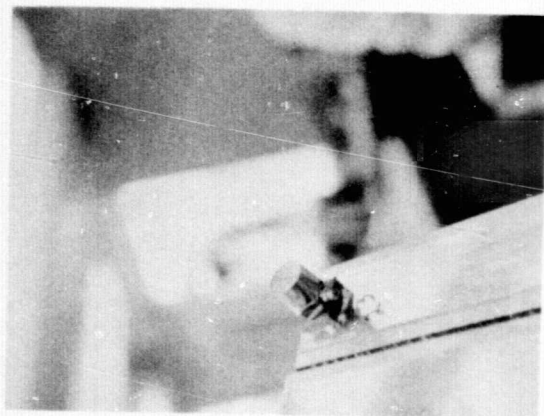
#35 Pulse Hgt. Analyzer (RIDL)



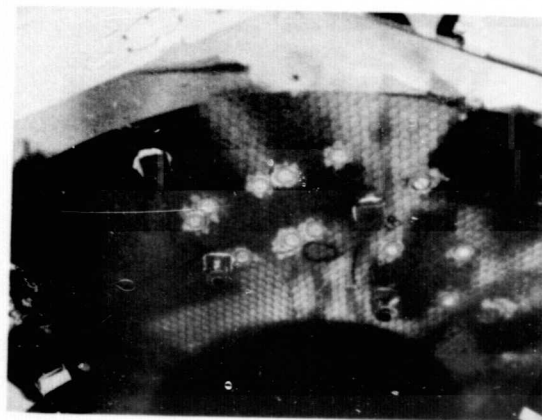
#34 SUI Electron Spect.
#42 Telemetry Encoder



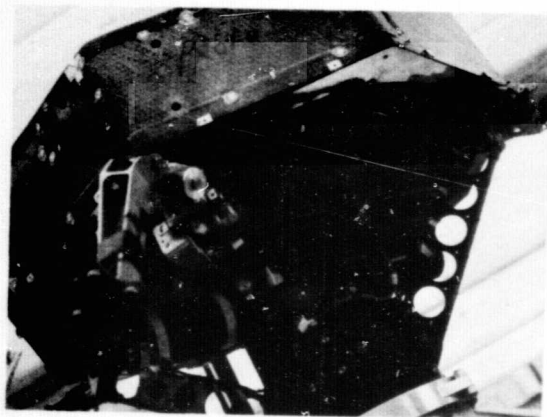
#34 SUI Electron Spect.
#42 Telemetry Encoder



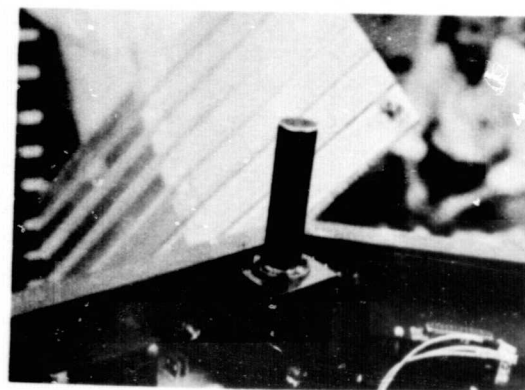
#23 Dummy Paddle



#32 SUI Data Encoder #28 G.M. Telescope



Double Scintillation Telescope



#1 G.M. Counter and Single Cry. Det.

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-37

JM	P.E.
FTM	S.H.
B	B.H.

6/5

Name of Test: Tensile Strength. (Birnbach Dial Cable, Nos. 1025 and 1053)

Date of Test: 3 May 61

Requested by: H. J. Cornille

Performed by: Sween

Purpose of Test: Determination of breaking strength of several dial cables, Birnbach Cat. Nos. 1025 and 1053.

Description of Article Tested (Photographs, if any):

- 1) Dial cable, Bronze, Birnbach Cat. No. 1025
- 2) Dial cable, Bronze, Birnbach Cat. No. 1053 braided

Test Equipment (Photographs, if any):

- 1) Dillon testing machine 300 lb. cap. using 100# scale and arm.
- 2) Wire fixture: Dillon No. Max. 1; Photo's included with test No. 300-9.

Test Procedure:

- 1) Measure
 - a. Number of strands
 - b. Strand diameter
 - c. Cable diameter
- 2) Attach cable (8 samples of each specimen) to wire fixture and find tensile strength.
- 3) Record results on drum chart. Recorder

Results (Photographs and charts, if any):

- 1) Drum chart record (attached)
- 2) Average tensile strength (ultimate)
 - a. Cat. No. 1025 = 68#
 - b. Cat. No. 1053 = 13.4#
- 3) Average strain
 - a. Cat. No. 1025 = 0.37"/8"
 - b. Cat. No. 1053 = 0.2"/8"

	No. 1025 *	No. 1053
No. of Strands	45	8
Strand Diameter	0.004"	0.005"
Cable Diameter	0.036"	0.024"

* 3 Strands of cotton in cable

Conclusions:

These cables may be usable for various devices (De-spin systems, escapements, etc.), which require non-magnetic materials.

H. J. Cornille

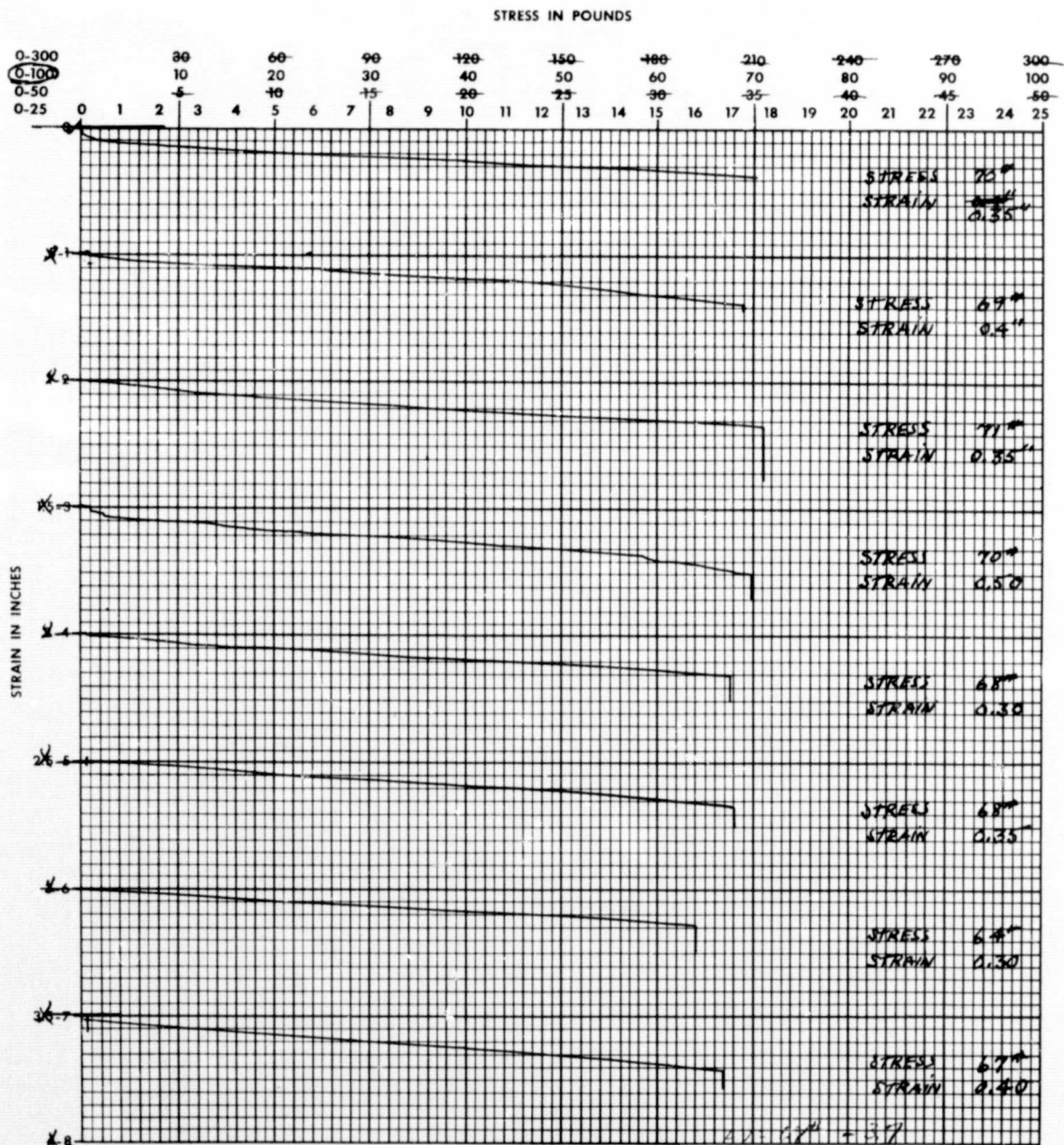
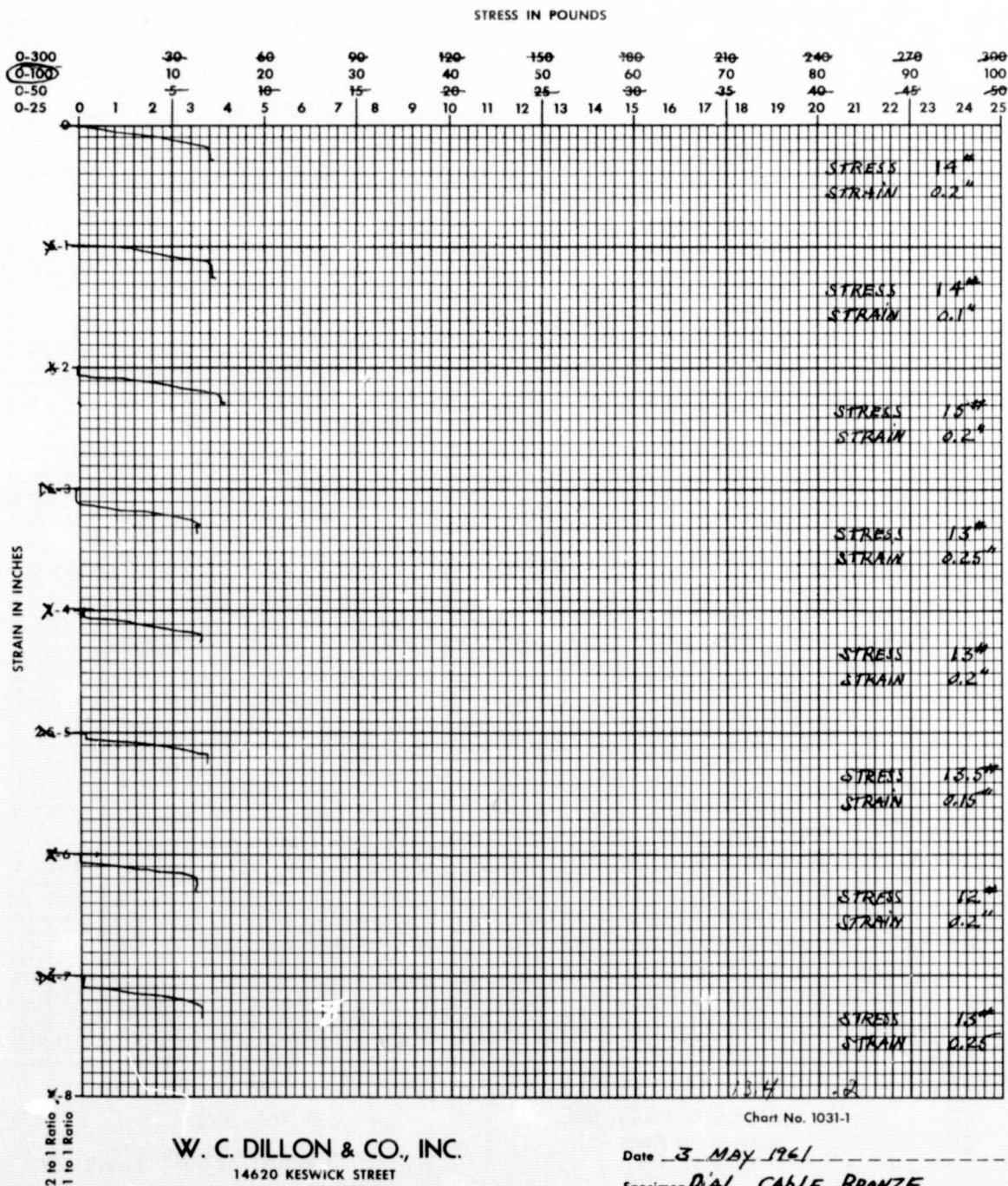


Chart No. 1031-1

W. C. DILLON & CO., INC.
14620 KESWICK STREET
VAN NUYS, CALIF.

Date 3 MAY 1961
Specimen DIAL CALLE, BRONZE
CAT. NO. 1025 LENGTH = 8"
Tester _____

C2



W. C. DILLON & CO., INC.
14620 KESWICK STREET
VAN NUYS, CALIF.

Date 3 MAY 1961
Specimen DIAL CABLE, BRONZE
CAF. No. 1003 LENGTH = 8'
Tester SWC:n

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-32

JM P.E.
FTM S.H.
B B.H.

5/4

INFORMAL TEST REPORT

Name of Test: Tensile Strength (Annealed Wire Rope)

Date of Test: 21 April 1961

Requested by: H. J. Cornille

Performed by: J. H. Kauffman and J. Sween

Purpose of Test: To find tensile strength of annealed 7 strand aircraft cable.

Description of Article Tested (Photographs, if any):

Same cable used in test No. 300-29 except these samples were annealed. (1/32" dia., 7 strand, type 304 stainless steel aircraft cable.)

Test Equipment (Photographs, if any):

Dillon Testing Machine 300 # cap. Wire fixture; Dillon No. Max 1; Photo's in Test No. 300-29

Test Procedure:

Attach cable (4 samples) to wire fixture and find tensile strength. Length of each sample was 6 inches record results on drum chart.

Results: (Photographs and graphs, if any):

Photo's enclosed with test No. 300-29 drum chart record.

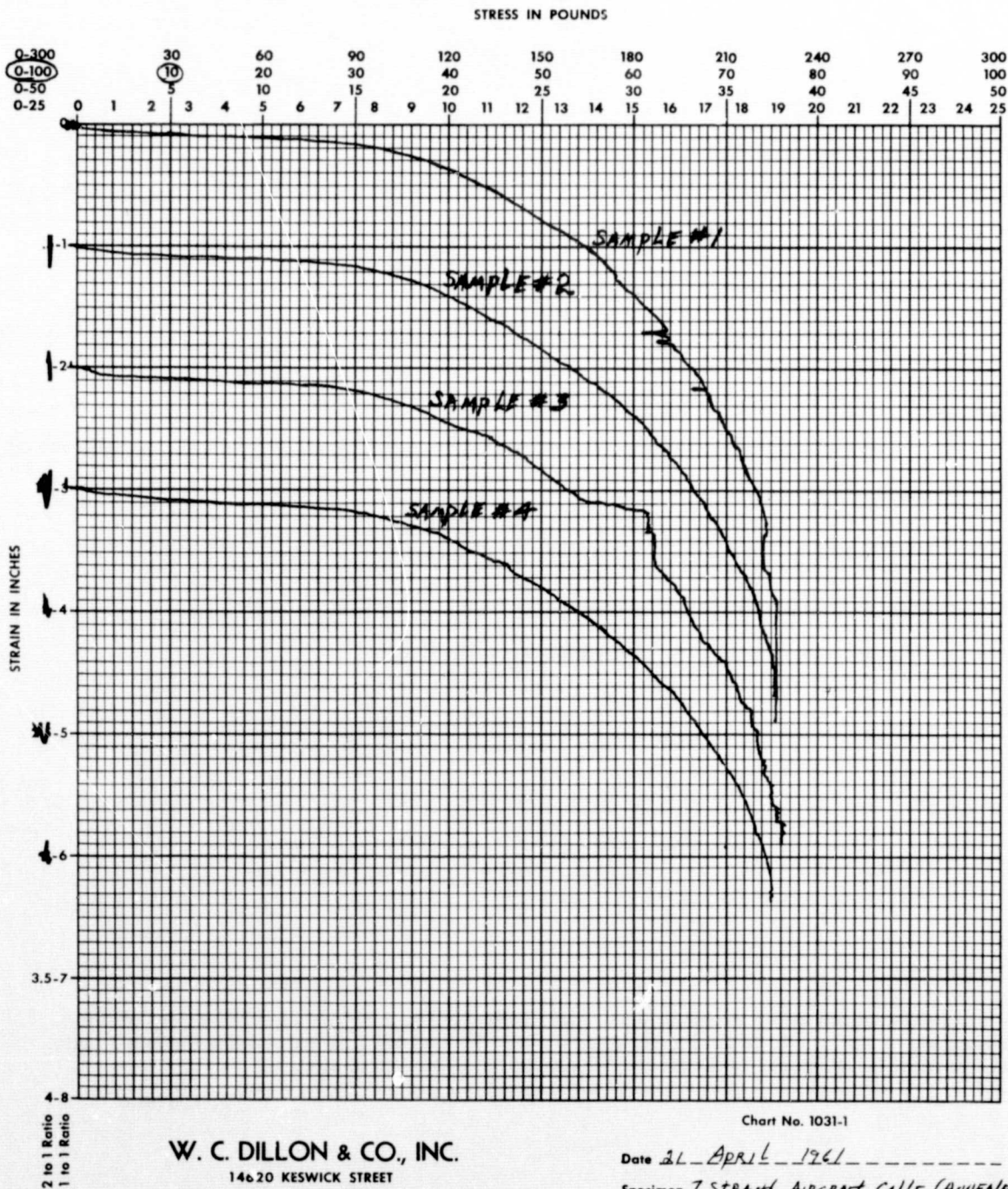
Sample	Ultimate Strength (lb)	Elongation (inches)
1	75.4	4.68
2	75.5	3.89
3	76.0	3.90
4	75.0	3.38

JS

Conclusions:

The elongation at the expected max. flight load (20#) is 0.12" or 2%. The effect of this elongation on the Yo-Yo is not known at this time. Therefore, this rope in the annealed state, will at least be temporarily discarded for use in the S-3 de-spin system.

H.J. Cornille



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-29

JM P.E.

FTM S.H.

B B.H.

4/25

Name of Test: Tensile Strength (Aircraft Hardened Wire)

Date of Test: 10 March 61

Requested by: H. J. Cornille

Performed by: J. Kauffman and J. Sween

Purpose of Test: Yield strength (lbs.)
Ultimate strength (lbs.)

Description of Article Tested (Photographs, if any):

Seven (7) strand stainless steel hardened
Aircraft cable
Cable diameter = 0.035"
Strand diameter = 0.011"

Test Equipment (Photographs, if any):

Dillon Universal Multi-Low-Range Testing Machine
Photo included

Test Procedure:

Self-aligning wire grips for specimens up to 1/8 inch were fastened to the cross head and dial arm of the Dillon Machine.

A twelve inch length of aircraft strand was clamped to the wire grips and the cross head was moved down the pressure columns by turning the crank at a constant rate until the cable broke. This test procedure was repeated seven times.

A permanent stress-strain record was made (see attached chart No. 1031-1).

Results: (Photographs and graphs, if any):

Sample No.	Yield Strength	Ultimate Strength	Strain (inches)
1	*	200 #	0.35 "
2	*	200 #	0.50 "
3	*	198 #	0.42 "
4	*	198 #	0.42 "
5	*	197 #	0.40 "
6	*	190 #	0.40 "
7	*	200 #	0.50 "

STRESS-STRAIN RECORD INCLUDED.

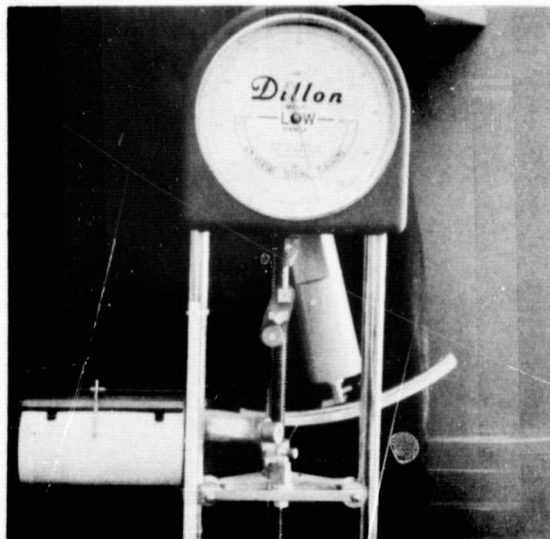
John Sween

* Approx. same as ultimate strength.

Conclusions:

- 1) Strand meets manufacturer's (Roebling's Sons) claimed strength characteristics.
- 2) Strand is suitable for use as wire in S-3 De-Spin system.

H. J. Cornille



Test Set-up

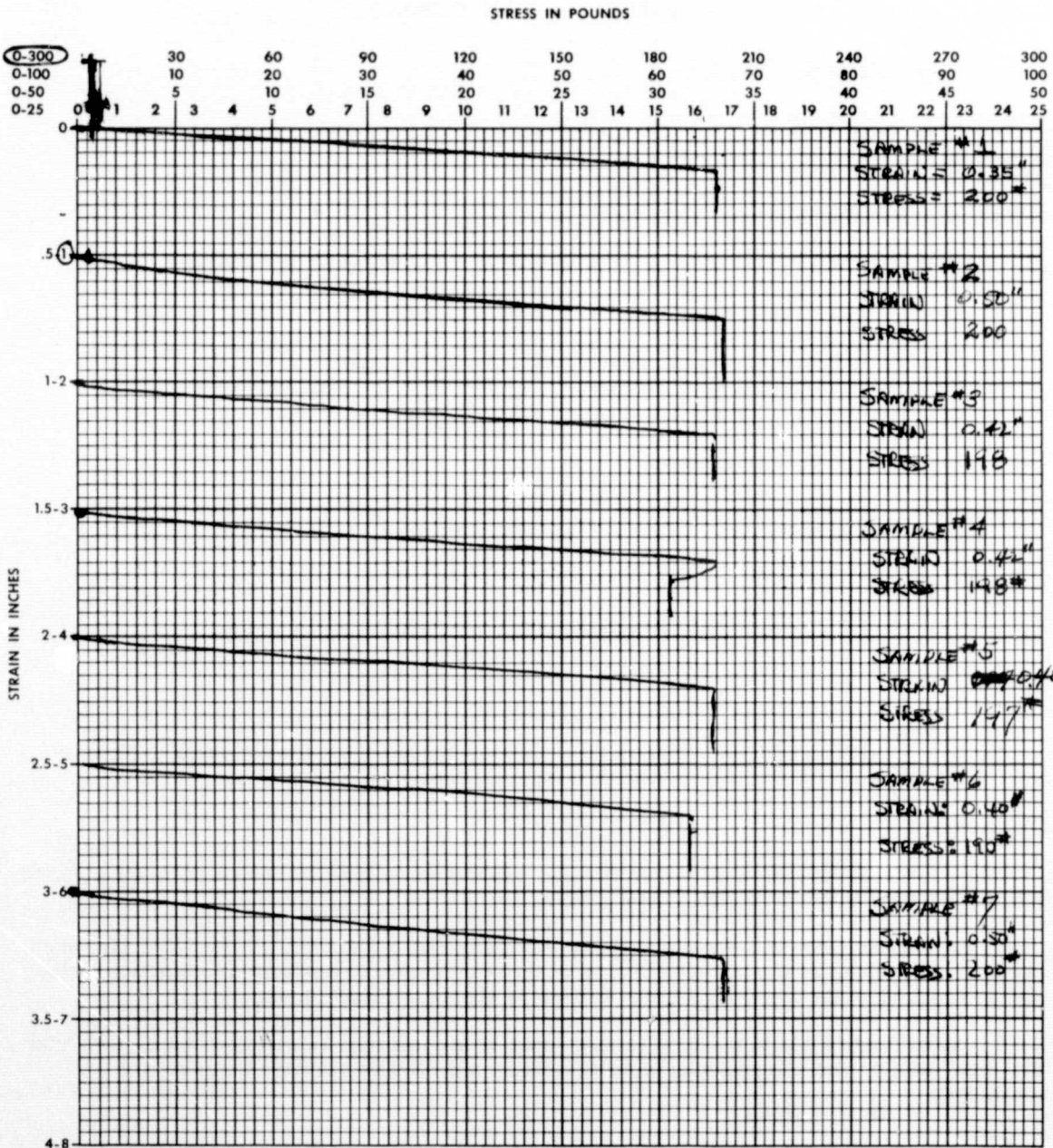


Chart No. 1031-1

W. C. DILLON & CO., INC.
14620 KESWICK STREET
VAN NUYS, CALIF.

Date 3 April 1961
* Specimen 7 STRAND STAINLESS STEEL CABLE
Tester J. SWEN - J. KAUFFMAN
* STRAND DIA: 0.064"
CABLE DIA: 0.035"

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-22
JM P.E.
FTM S.H.
RCB B.H.

INFORMAL TEST REPORT

Name of Test: Fastener Pull Test

Date of Test: 24 Oct. 60

Requested by: J. Madey

Performed by: J. H. Kauffman, F. N. LeDoux

Purpose of Test: To determine the point of failure of the honeycomb or fastener.

Description of Article Tested (Photographs, if any):

1. Original S-3 honeycomb structure (#1 engineering model)
2. "Madey" fastener and Epon 828 epoxy
3. #8 Delron type (NWP) and Hysol filled with vent hole.

Test Equipment (Photographs, if any):

Dillon testing machine
Adapter - see sketch #1

Test Procedure:

Pull samples at constant rate and record strain and stress on drum chart.

Results:

See charts

None of the fasteners failed. The failure is in the honeycomb. The top layer pulls away from the honeycomb and the bottom pushes up into the honeycomb.

Conclusions:

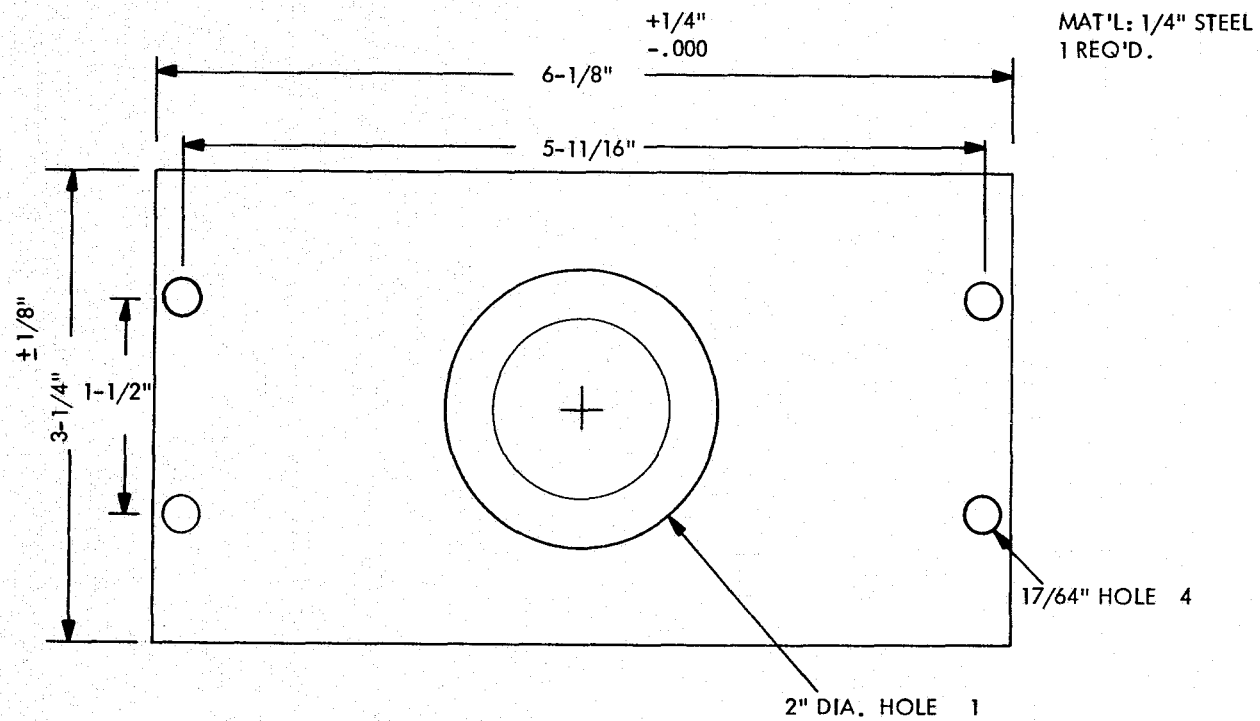
The point of failure in all specimens tested was the honeycomb structure. Failure occurred in the immediate area surrounding the fastener.

It was noticed prior to testing that there was distortion of the cellular structure that was caused by the setting of the fasteners. I am of the opinion that any amount of distortion or localized crushing of the panel constitutes excessive stress at these points.

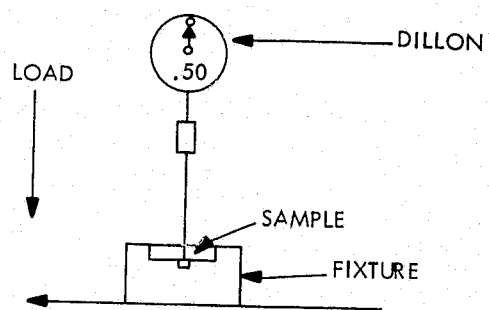
I believe it advisable to perform further tests on the material in question and in particular "flatwise" tension and compression tests at ambient and slightly elevated temperature conditions.

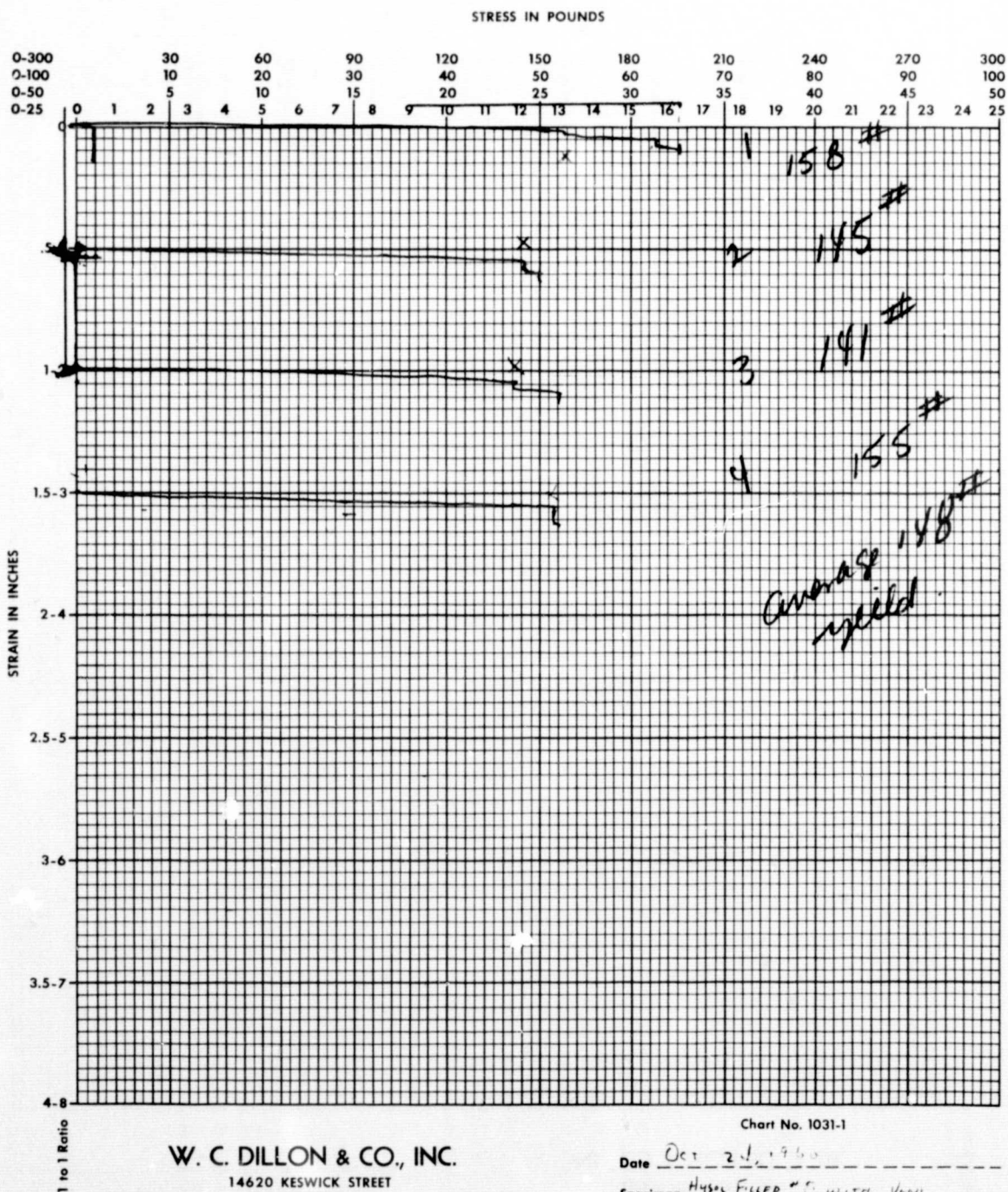
F. N. LeDoux

101



REMOVE ALL SHARP EDGES.





W. C. DILLON & CO., INC.

14620 KESWICK STREET

VAN NUYS, CALIF.

Mr. G. VAN NUYS, CALIF.
ULTIMATE 18"

AUG 1 STRESS = 160"

Date Oct 21, 1960

Specimen Hysol Filled #1 WITH VANI

Tester J. H. KAEGERMAN

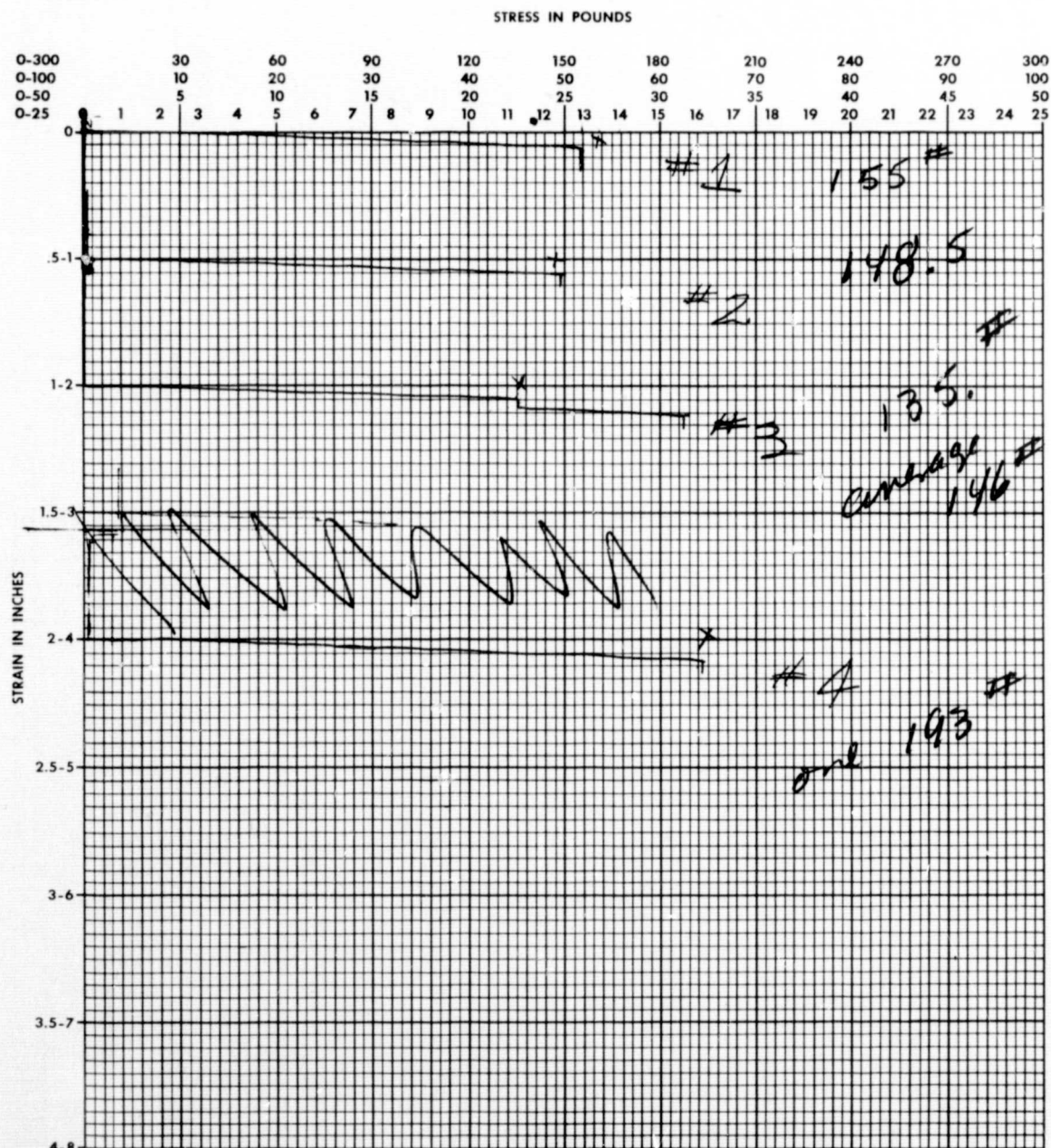


Chart No. 1031-1

W. C. DILLON & CO., INC.

14620 KESWICK STREET
VAN NUYS, CALIF.

As Specimen = 3/16"
ULTIMATE
AVG STRESS = 180#

Date Oct. 24, 1960

Specimen L.M. INDIAN FURNACE (P.R. 5-2 STRUTTING)

Tester J.W. KAVANAGH

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-9
JK P.E.
FNL S.H.
B B.H.
12/15

Name of Test: Tensile Strength (7 strand control cable)

Date of Test: 18 Nov. 60

Requested by: J. H. Kauffman (H. J. Cornille)

Performed by: J. H. Kauffman

Purpose of Test: To find tensile strength of 7 strand control cable.

Description of Article Tested (Photographs, if any):

Stainless steel control cable; Diameter = 0.018";
7 strand; Strand diameter = 0.006".

Test Equipment (Photographs, if any):

1. Dillon testing machine 300# cap.
2. Wire fixture; Dillon No. Max.1.

Test Procedure:

1. Measure a) no. of strands b) strand diameter c) cable diameter
2. Attach cable (6 samples) to wire fixture and find tensile strength.
3. Record results on drum chart.

Results: (Photographs and graphs, if any):

Drum chart record

Average tensile strength = 44.85#

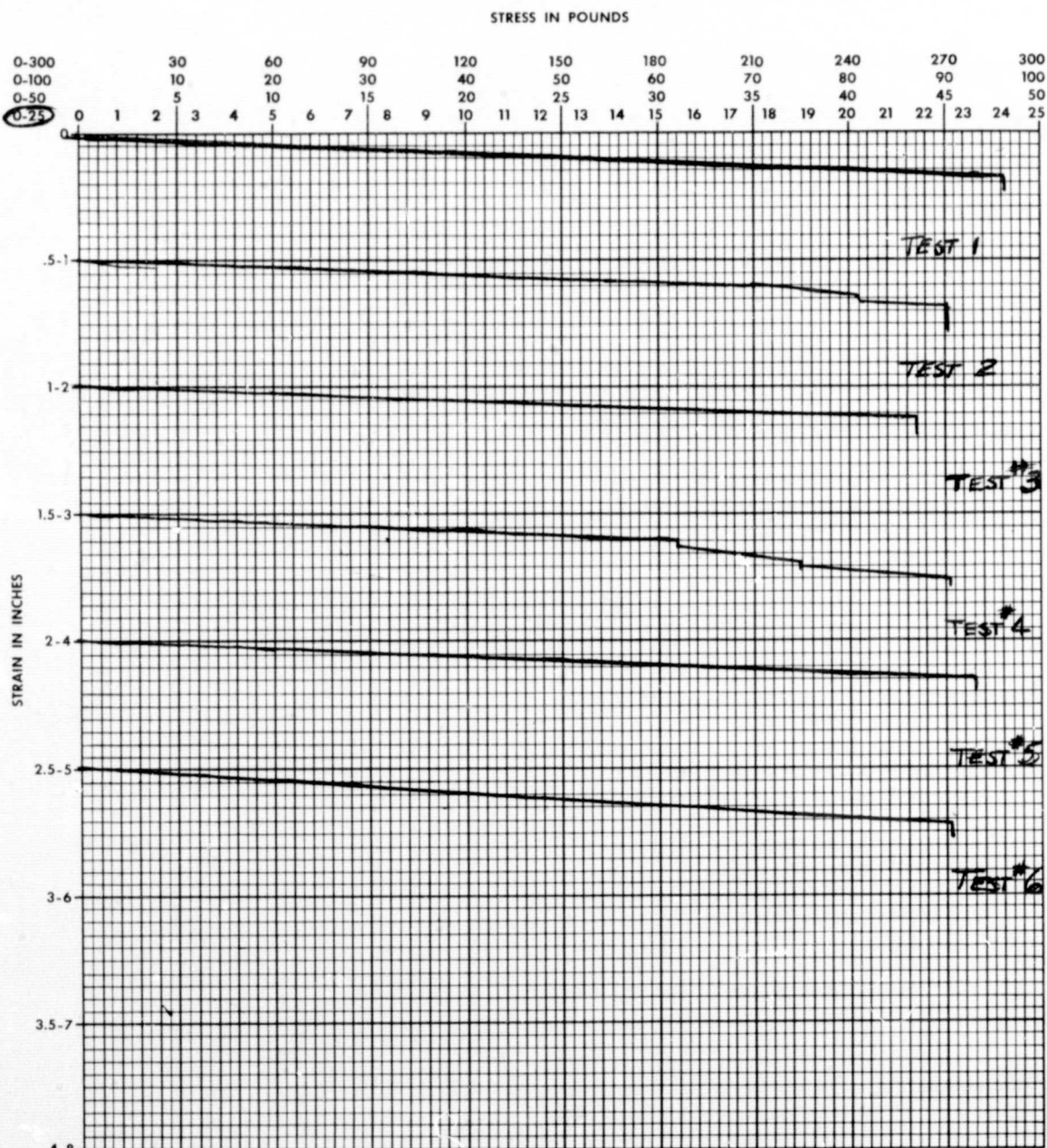
Average strain = .35" corrected strain = 0.33"

1. Number of strands = 7
2. Strand diameter = 0.006"
3. Cable diameter = 0.018"
4. Stress of cable (average)

$$S = D/g$$

$$S = 44.85/3.14 \times (0.009)^2 : S = 185,000\#/in^2$$

Conclusions:



2 to 1 Ratio
1 to 1 Ratio

W. C. DILLON & CO., INC.
14620 KESWICK STREET
VAN NUYS, CALIF.

Chart No. 1031-1

Date 15 NOVEMBER, 1960
Specimen 7 STRAND (STRAND: 206)
CONTROL CABLE CABLE DIA = 0.018
Tester J. H. KALEMAN

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-5

JK P.E.

FNL S.H.

B B.H.

11/14/60

Name of Test: Cable Test

Date of Test: 14 Nov. 60

Requested by: F. N. LeDoux

Performed by: W. E. Smith and J. H. Kauffman

Purpose of Test:

1. Find number of strands
2. Find diameter of strands
3. Find diameter of cable
4. Find tensile strength of cable

Description of Article Tested (Photographs, if any):

Stainless steel control cable diameter = 0.0145"

Test Equipment (Photographs, if any):

1. Dillon testing machine - 50# range
 2. Wire fixture
- Photo No. 1

Test Procedure:

1. Cut cable and count number of strands and measure diameter of 1 strand.
2. Measure cable diameter.
3. Attach cable to Dillon and wire fixture and find tensile strength.
4. Record results on drum chart.

Results: (Photographs and graphs, if any):

Drum chart recording (stress in pounds vs. strain in inches). Sample broke at 26# and moved 0.3" - C.R. factor of .09 . The corrected strain = 0.21".

1. Number of strands = 7
2. Diameter of strands = 0.0045"
3. Diameter of cable = 0.0145"
4. Stress strength of cable

$$S = P/a$$

a is not a true cross-sectional area

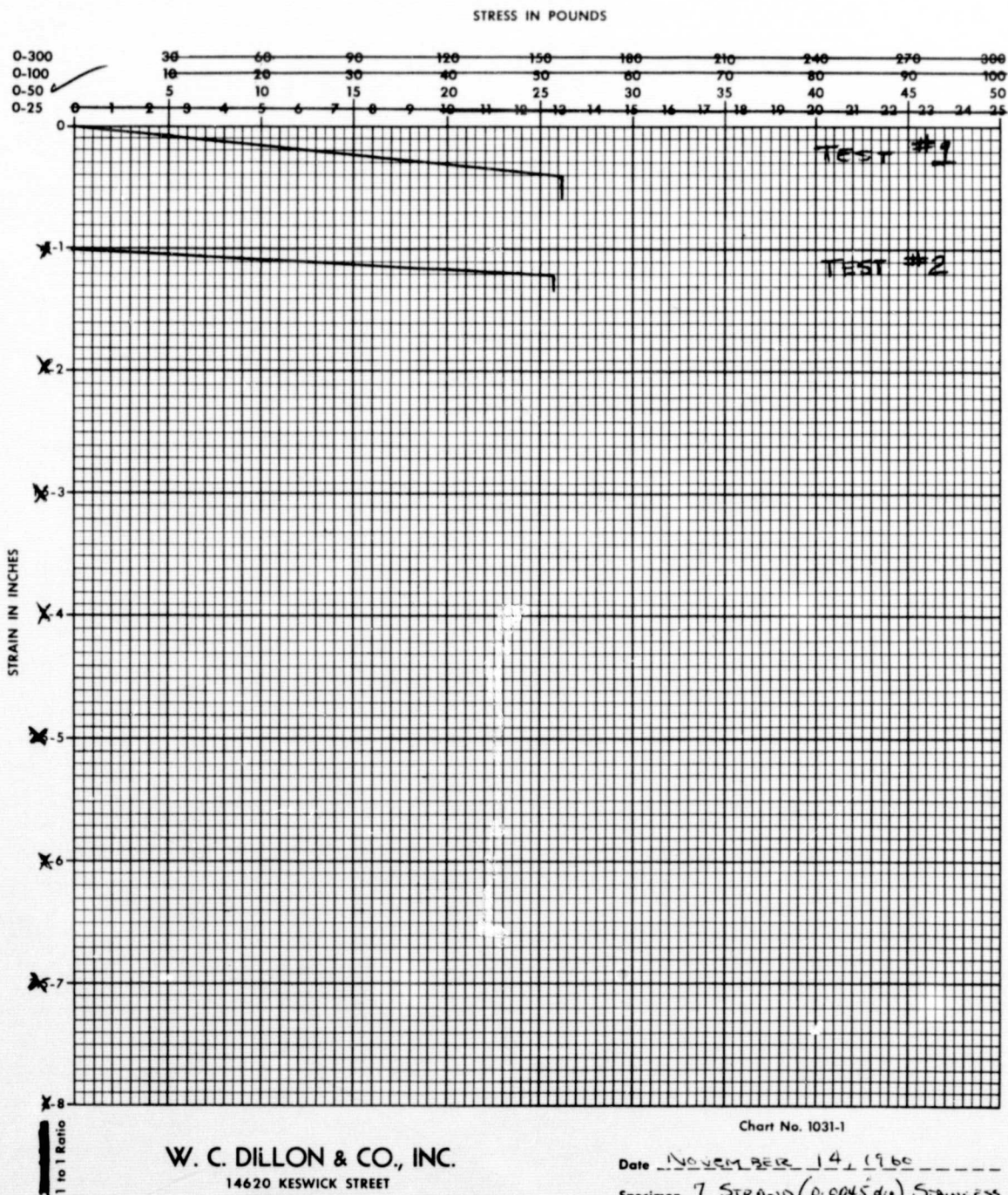
$$S = 26/\pi(0.0073)^2$$

$$S = 176,700 \text{ #/in}^2$$

Conclusions:

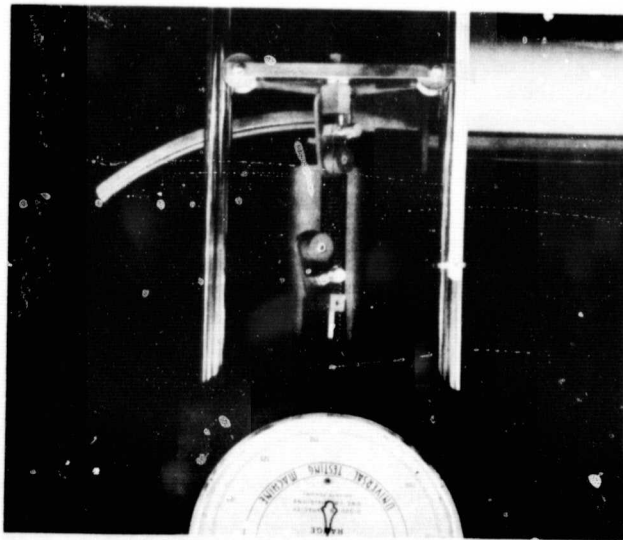
The cable will take 176,700#/in.² before complete failure. (Only enough cable to make 2 tests).

James Kauffman

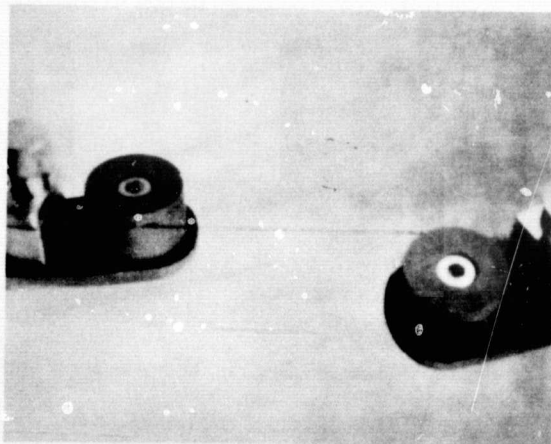


W. C. DILLON & CO., INC.
14620 KESWICK STREET
VAN NUYS, CALIF.

Date NOVEMBER 14, 1960
Specimen 7 STRAND (0.0045 in) STAINLESS
STEEL CONTROL CABLE (0.0145 in)
Tester W. SMITH & J. KAUFFMAN



Test Set-up



No. 1

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 700-9
ET P.E.
FTM S.H.
RCB B.H.

Name of Test: Determination of "K" (yo-yo springs) S-3A

Date of Test: 27 Oct. 61 - 31 Oct. 61

Performed by: Sween

Purpose of Test: Determine "K" of springs

Description of Article Tested (Photographs, if any):

Picture included
Ten (10) springs 0.080" d. steel
Six (6) springs 0.027" d. steel

Test Equipment (Photographs, if any):

Lab "A" frame
Two (2) lb. weight pan
Two (2) and five (5) lb. Fairbanks and Morse weights
Drill chucks

Test Procedure:

1. Fix a drill chuck to each end of the spring.
2. Clamp one chuck to the lab. "A" frame.
3. Measure the free length of the spring-record.
4. Load springs nos. 1 thru 10 with a total of 35 lb.-record.
Load springs nos. 11 thru 16 with a total of 14 lb.-record.
5. Load springs nos. 1 thru 10 in 5 lb. increments to a maximum of 35 lb.-record.
6. Load springs nos. 11 thru 16 in 2 lb. increments to a maximum of 14 lbs. record.

Note: Springs had a pre stress as recorded in red on the data sheet and were heat treated for one-half (1/2) hour at 600°F.

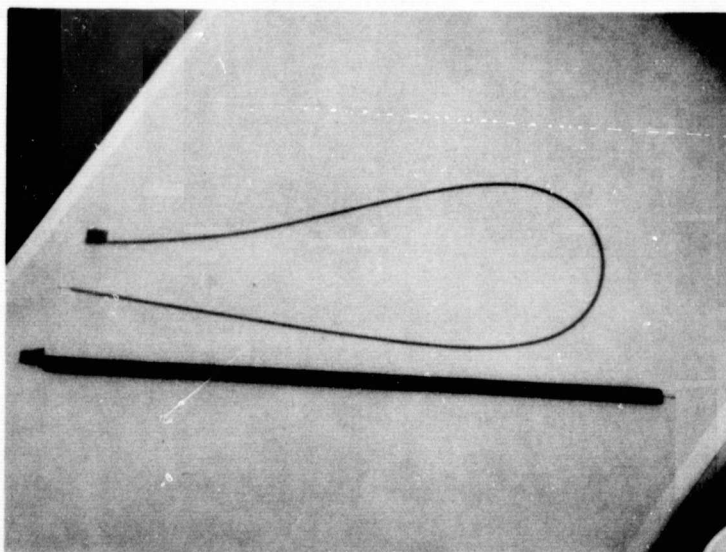
Results: (Photographs and graphs, if any):

Data sheet included.
JS

Conclusions:

1. The .080 Dia wire springs have average "K" spring constant of 1.07#/inch between zero and 32.5" deflection.
2. The .027 wire springs have "K" of .87 lbs./in. between zero and 16.062 inches deflection.
3. Permanent set was negligible after loading.
4. Above data to be used as reference in final design of yo-yo stretch design.

E. W. Travis



Test Springs

DETERMINATION OF "K" OF SPRINGS

31 November 1962

0.080" d

Load Lbs.	Spr. 1	Spr. 2	Spr. 3	Spr. 4	Spr. 5	Spr. 6	Spr. 7	Spr. 8	Spr. 9	Spr. 10
0	27-5/8	27-5/8	27-5/8	27-1/2	27-5/8	27-5/8	27-5/8	27-9/16	27-1/2	27-5/8
35	60-1/8	55-3/4	55-3/4	54-1/16	55-3/16	56-5/16	55-5/8	56-7/16	55-7/8	56-1/8
0	27-5/8	27-5/8	27-5/8	27-1/2	27-5/8	27-5/8	27-5/8	27-9/16	27-1/2	27-5/8
5	27-13/16	27-5/8	27-5/8	27-1/2	27-5/8	27-5/8	27-5/8	27-9/16	27-1/2	27-5/8
10	32-5/16	28-15/16	28-1/8	28-1/2	28-1/2	28-5/8	29-1/16	28-15/16	28	28-3/16
15	38	34-3/16	33-1/2	32-11/16	33-3/4	33-7/8	34-3/8	34-7/16	33-7/16	33-3/8
20	43-1/2	39-9/16	39-1/16	37-15/16	39-1/4	39-7/16	39-11/16	39-15/16	39	39-1/16
25	49-1/8	44-15/16	44-5/8	43-5/16	44-5/8	45-1/8	45-1/16	45-7/16	44-5/8	44-13/16
30	54-9/16	50-3/8	50-3/16	48-5/8	50	50-3/4	50-7/16	50-15/16	50-1/4	50-1/2
35	60-3/16	55-3/4	55-3/4	53-15/16	55-1/4	56-5/16	55-5/8	56-7/16	55-7/8	56-1/8
30	54-9/16	50-3/8	50-3/16	48-5/8	50	50-3/4	50-7/16	50-15/16	50-1/4	50-1/2
25	49-1/8	44-15/16	44-5/8	43-5/16	44-5/8	45-1/8	45-1/16	45-7/16	44-5/8	44-13/16
20	43-1/2	39-9/16	39-1/16	37-15/16	39-1/4	39-7/16	39-11/16	39-15/16	39	39-1/16
15	38	34-3/16	33-1/2	32-11/16	33-3/4	33-7/8	34-3/8	34-7/16	33-7/16	33-3/8
10	32-5/16	28-15/16	28-1/8	28-1/2	28-1/2	28-5/8	29-1/16	28-15/16	28	28-3/16
5	27-13/16	27-5/8	27-5/8	27-1/2	27-5/8	27-5/8	27-5/8	27-9/16	27-1/2	27-5/8
0	27-5/8	27-5/8	27-5/8	27-1/2	27-5/8	27-5/8	27-5/8	27-9/16	27-1/2	27-5/8

0.027" d

TEST BEFORE HEAT TREATING
OF 0.080" d SPRING

Load Lbs.	Spr. 11	Spr. 12	Spr. 13	Spr. 14	Spr. 15	Spr. 16		Load Lbs.	Spr. 1	
0	51-3/8	51-1/4	51-1/4	51-1/4	51-5/16	51-1/4		0	27-1/4	
14	67-7/16	62-7/16	62-5/8	62-5/8	63-1/8	62-9/16		35	41-1/8	
0	51-3/8	51-1/4	51-1/4	51-5/16	51-5/16	51-1/4		0	27-1/4	
2	53-3/16	51-5/16	51-5/16	51-5/16	51-5/16	51-5/16		5	27-1/4	
4	55-9/16	52-9/16	52-5/8	52-5/8	52-11/16	52-11/16		10	27-1/4	
6	57-15/16	54-9/16	54-5/8	54-11/16	54-7/8	54-11/16		15	27-1/4	
8	60-5/16	56-9/16	56-5/8	56-11/16	56-7/8	56-11/16		20	27-3/8	
10	62-11/16	58-5/8	58-5/8	58-11/16	59	58-11/16		25	29-5/16	
12	65	60-9/16	60-5/8	60-11/16	61-1/16	60-11/16		30	35-3/16	
14	67-7/16	62-9/16	62-5/8	62-11/16	63-1/8	62-11/16		35	41-1/16	
12	65	60-9/16	60-5/8	60-11/16	61-1/16	60-11/16		30	35-3/16	
10	62-3/4	58-9/16	58-5/8	58-11/16	59	58-11/16		25	29-5/16	
8	60-5/16	56-9/16	56-5/8	56-11/16	56-15/16	56-11/16		20	27-3/8	
6	58	54-9/16	54-5/8	54-11/16	54-7/8	54-11/16		15	27-1/4	
4	55-5/8	52-9/16	52-5/8	52-11/16	52-3/4	52-11/16		10	27-1/4	
2	53-1/4	51-5/16	51-5/16	51-5/16	51-5/16	51-5/16		5	27-1/4	
0	51-3/8	51-1/4	51-1/4	51-5/16	51-5/16	51-1/4		0	27-1/4	

V - INITIATORS AND EXPLOSIVE TESTS S-3

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-41

JM P.E.

FTM S.H.

B B.H.

5/22/61

INFORMAL TEST REPORT

Name of Test: Dimple Motor, Vacuum Soak Test

Date of Test: 16 May 61

Requested by: H. J. Cornille

Performed by: J. H. Kauffman and J. Sween, Jr.

Purpose of Test: To find if four (4) T-3E1 type dimple motors will fire after two and one half hours at an environment of 120°F. and 10 mm Hg pressure.

Description of Article Tested (Photographs, if any):

T-3E1 Dimple Motors See photo No. 1

Test Equipment (Photographs, if any):

Resistance tester (J. Bush - home made type - low voltage)
Hot-Pac-Vacuum oven
Battery Pac (9 VDC)

Test Procedure:

1. Measure resistance of (4) four dimple motors. Mark and record resistance.
2. Place the (4) four dimple motors in the oven at 120°F.
3. Pump the oven chamber to 10 mm pressure.
4. Remove the (4) four dimple motors from the oven after (2-1/2) two and one half hours of soak.
5. Measure resistance of the (4) four dimple motors and record.
6. See if the (4) four dimple motors will ignite at 9 VDC and record.

Results: (Photographs and graphs, if any):

Dimple Motor No.	Resistance		Volts	Actuated	
	Before	After		Yes	No
1	7.4Ω	7.4Ω	9	x	
2	6.9Ω	6.9Ω	9	x	
3	6.9Ω	6.9Ω	9	x	
4	6.6Ω	6.6Ω	9	x	

Note: #1 Dimple Motor Blew.

Conclusions:

1. No difficulty should be experienced in conducting the vacuum tests of the de-spin system at Langley. The hardest vacuum to be pulled for these tests is 10 mm Hg, and the pumping time required in the 41 ft. sphere is 1 hr. 45 min.

2. The separation of the jacket (casing) in the case of dimple motor No. 1 is the second such experience in approximately 100 actuations. This will not affect the operation of the de-spin system, but does emit a small quantity of undesirable products of combustion.

3. As expected, a low pressure environment has no effect on the T-3E1 dimple motor when exposed for short durations.

H. J. Cornille

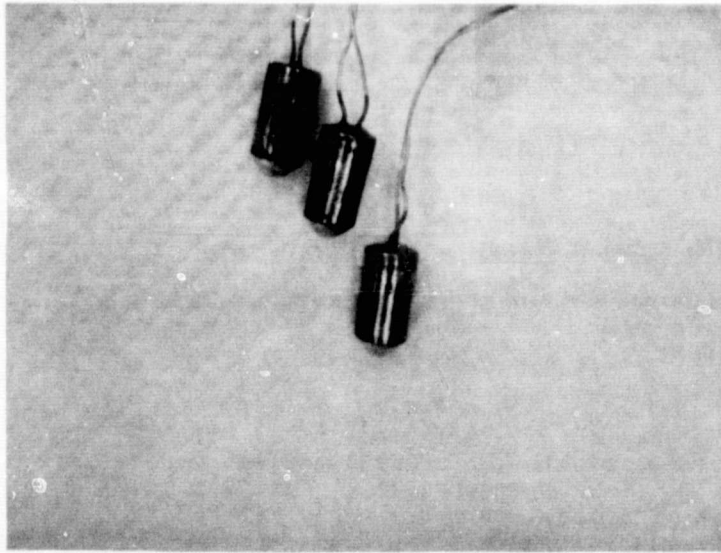


Photo No. 1

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-49

JM	P.E.
FTM	S.H.
RCB	B.H.

Name of Test: Transient Study for Dimple Motor Detonation

Date of Test: 16 Aug. 61

Requested by: J. Webb

Performed by: Peterson and Webb

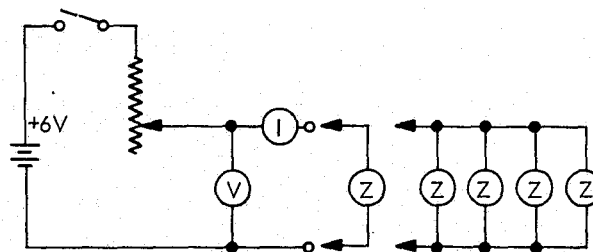
Purpose of Test: To determine parameters for firing T-3 Dimple Motors.

Description of Article Tested (Photographs, if any):

Atlas Powder Company - T-3 Dimple Motor
Bridge Resistance 5-8 Ω

Test Equipment (Photographs, if any):

See schematic.



FIRING VOLTAGE & CURRENT SCHEMATIC

Test Procedure:

The wiring of the satellite was duplicated (as near as possible) in length, wire size, physical position, etc. Various air coupled inputs were turned on to cause detonation. These inputs consisted of all types of inductive discharge from soldering irons (gun), high voltage Tesla-coil, and various induced currents, etc.

Results and Conclusion:

The max. voltage that could be measured was 0.5 V PP. This is not considered sufficient voltage to detonate dimple motors.

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-48

JM P.E.
FTM S.H.
RCB B.H.

INFORMAL TEST REPORT

Name of Test: Minimum Firing Current of T-3 Dimple Motors

Date of Test: 16 Aug. 61

Requested by: J. Webb

Performed by: Peterson and Webb

Purpose of Test: To determine the minimum firing current of dimple motor type T-3 which were used for S-3 yo-yo activation.

Description of Article Tested (Photographs, if any):

Atlas Powder Co. T-3 Dimple Motor

Test Equipment (Photographs, if any):

See schematic

Test Procedure:

Current is applied in an increasing manner by varying a potentiometer. The current and voltage are constantly maintained to determine the point at which detonation occurs.

1. Six motors are tested individually.
2. Four motors are tested in parallel.

Results:

No.	Resistance Ω	Voltage Volts	Current ma	Resistance Apparent Firing Ω	Remarks
1	8.15	1.18	105	11.24	.124 w
2	7.90	1.68	105	16.00	.176 w
3	7.19	1.36	113	12.04	.154 w
4	5.15	1.16	85	13.65	.098 w
5	7.75	0.92	108	8.52	.099 w
6	8.10	0.88	80	11.00	.0705 w
7	4.80	0.68	320	2.13	
	7.95				
	6.45				
	8.15				

Conclusions:

Max. non-fire is advertized as 50 ma. Min. fire borderline is 250 ma. Recommended fire current is 1 amp.

Above information is for an equivalent Hercules Dimple Motor type M-4.

The above results establish the minimum current for detonation. This appears to be 80 ma, although not completely established. This would require a long-time study. The apparent firing resistance is explained by the fact that the resistance wire heats and increases (as in a light bulb).

J. B. Webb

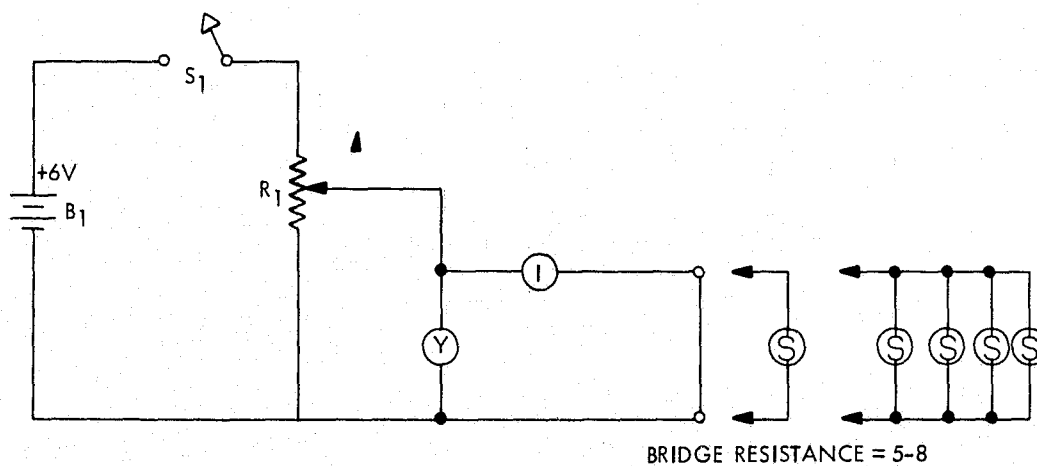


Figure 1 - Firing Voltage and Circuit Schematic

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-47
JM P.E.
FTM S.H.
RCB B.H.

INFORMAL TEST REPORT

Name of Test: Dimple Motor Firing Through π filter.

Date of Test: 10 Aug. 61

Requested by: J. Webb

Performed by: Peterson, Corbin, Webb

Purpose of Test: To determine firing current through a π filter.

Description of Article Tested (Photographs, if any):

Atlas Powder Company T-3 Dimple Motor.
Bridge Resistance 5-8 Ω .

See schematic.

Test Equipment (Photographs, if any):

See schematic and diagram.

Test Procedure:

The physical arrangement in the satellite was duplicated as near as possible and the wires connected to a regulated 20 V DC power supply. A Sanborn Recorder was connected on one leg of the filter and the Dimple Motors were fired.

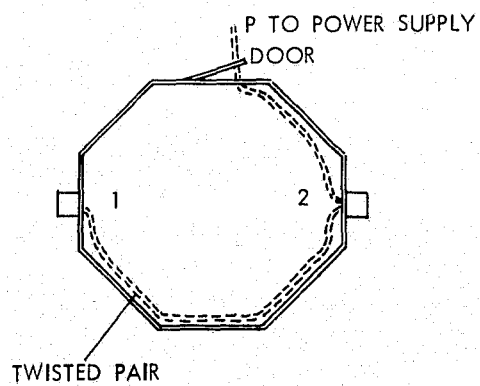
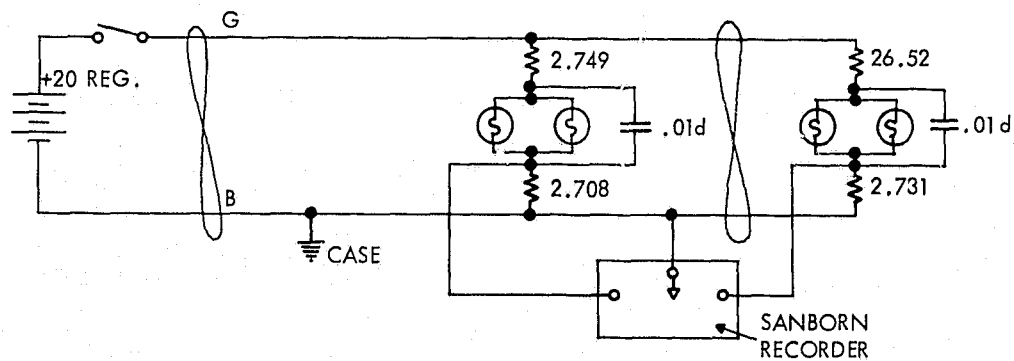
Results:

All four motors fired with no apparent delay.
Set #1 drew 1.77 amps.
Set #2 drew 1.184 amps.

Firing time is not available from Sanborn Recorder.

Conclusions:

There is no apparent difficulty in firing these Dimple Motors with the low pass filter connected. If the current were equally divided, there would be at least .5A to each motor which is twice the minimum firing current - - - even if one fired, the other in parallel with it would fire soon after since this current would then be available. The apparent difference in firing currents can only be explained because of the difference in apparent firing resistance.



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-36

JM	P.E.
FTM	S.H.
RCB	B.H.

2/18

Name of Test: Explosive, Energy Level Comparison

Date of Test: Dec. 10, 1959

Performed by: F. LeDoux

Purpose of Test: To compare the energy levels of the following initiators:

1. MK 1 Mod 0
2. MK 114 Mod 2
3. MK 131 Mod 0

Description of Article Tested (Photographs, if any):

An initiator is an explosive charge encased in a copper casing and ignited electrically by means of a bridge (resistance) wire. All initiators were .281" dia. and 3/8" long.

Test Equipment (Photographs, if any):

Initiators	Photograph #72
Vacuum Chamber	
Battery Pack	

Test Procedure:

1. Place 1 each of the above initiators in a paper container (made by Retco of Phila. Pa., type: Big chief 1/2 pint liquid) and ignite in oven (for protection). Ignite separately.
2. Place 1 each of the above initiators in the vacuum chamber and cover each with a 4 oz. paper cup (size #4B sanitary cup by American Lace Paper Co.) and ignite separately. (.03 Microns)

Results: (Photographs and graphs, if any):

Oven test:

1. The MK 131-0 initiator completely destroyed the container.
2. The MK 114-2 initiator blew cover off container.
3. The MK 1-0 caused no movement or damage.

Vacuum Chamber test:

1. MK 131-0 damaged glass dome (from copper shrapnel)
2. MK 114-2 deformed cup completely
3. MK 1-0 ejected cup approximately 18" above base with no visible damage to cup.

Conclusions:

The MK 131-0 has by far the most energy of the three initiators with the MK 114 Mod 2 next and the MK 1 Mod 0 the least. All of the above initiators contaminated the paper containers about the same amount (Black powdery residue covering the inner surface of the containers). The MK 131 Mod 0 and MK 114 Mod 2 can be classified as highly dangerous detonaters due to flying shrapnel that emanates from the copper casing.

J. M. Madey

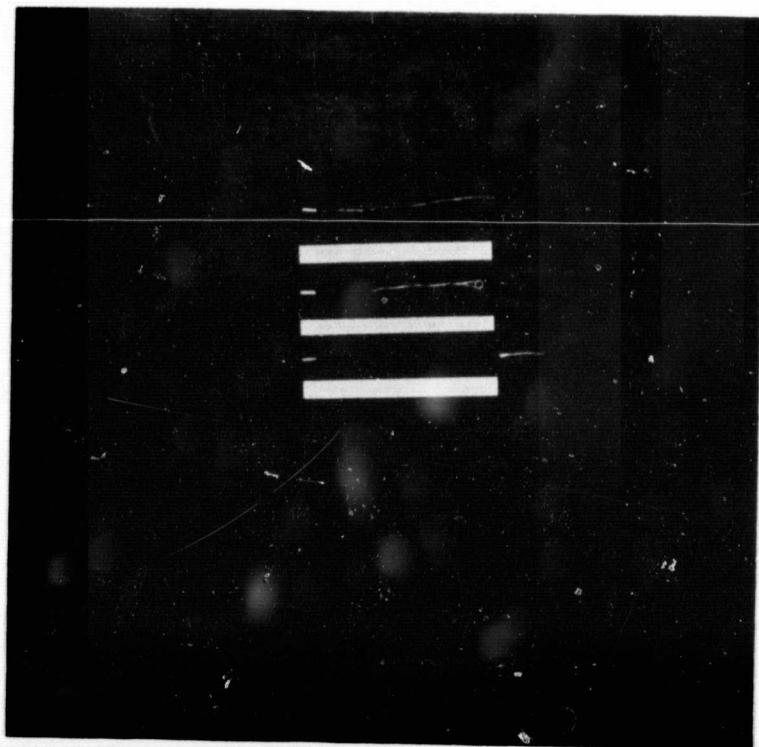


Photo No. 1

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-31

JM	P.E.
FTM	S.H.
B	B.H.

4/25

Name of Test: Dimple Motor Qualification Temperature Test

Date of Test: 20 April 61

Requested by: H. J. Cornille

Performed by: J. H. Kaufmann

Purpose of Test: 1. To find if the Dimple Motors will fire (ignite) after 40 minutes at 65°C.
2. Find if 40 minutes at 65°C will affect Dimple Motor Resistance.

Description of Article Tested (Photographs, if any):

Dimple Motors (T 3E-1)

Test Equipment (Photographs, if any):

Resistance Tester (J. Bush - homemade - low voltage)
Blue M Oven #OV - 18A
Battery Pac 11.5 VDC

Test Procedure:

Procedure A

1. Measure resistance of (4) dimple motors before heat.
2. Place (4) dimple motors in yo-yo bodies.
3. Place the above assembly in oven at 65°C. for 40 minutes.
4. (a) Remove the assembly (b) Measure resistance (c) Fire dimple motors 12 VDC max. - record resistance before and after heat.

Procedure B

1. Repeat parts 1 - 3 of procedure A.
2. Fire dimple motors in their yo-yo bodies in oven after 40 minutes at 65°C.

Results: (Photographs and graphs, if any):

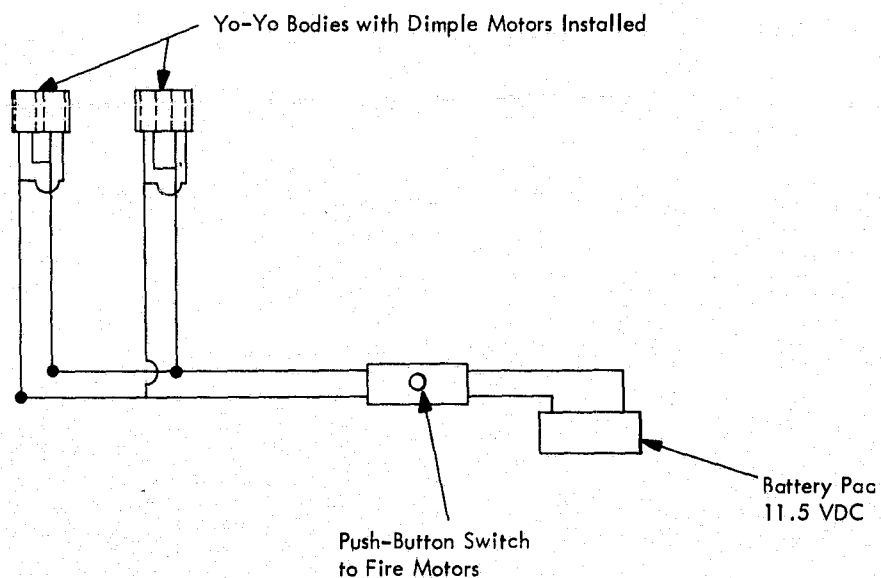
All dimple motors fired in procedure A and B with 11.5 VDC.

Motor No.	Ω Before Heat	Ω After Heat	V DC	Procedure
1	6.3	6.25	11.5	A
2	6.65	6.6	↓	↓
3	6.5	6.45	↓	↓
4	6.4	6.4	↓	↓
1	6.2	X	11.5	B
2	6.85		↓	↓
3	7.25		↓	↓
4	7.45		↓	↓

Conclusions:

T 3E-1 dimple motors qualify for use in the S-3 de-spin system, since according to the thermal branch the max. temperature they will be subjected to will be 10°C. above launch ambient. Max. time from launch to de-spin will be 30 min.

J. H. Kauffman & H. J. Cornille



Note: In Procedure B wires were extended through top vent of oven to the switch.

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-25

JM	P.E.
FTM	S.H.
B	B.H.

4/25

Name of Test: Dimple Motor Heat and Ignition Test

Date of Test: 1 March 61

Requested by: J. Madey

Performed by: J. H. Kauffman and J. Sween

Purpose of Test: To find if dimple motors (#T 3E 1) would ignite after 10 minutes saturation at 205°C. Resistance (Ω) before and after saturation.

Description of Article Tested (Photographs, if any):

Type T-3E1 dimple motors

Test Equipment (Photographs, if any):

Resistance tester (J. Bush - homemade - low voltage)
Hot-pac oven
Battery-pac (9 VDC)

Test Procedure:

1. Measure resistance of (5) dimple motors and record.
2. Place the (5) dimple motors in oven at 205°C.
3. Remove the (5) dimple motors after 10 minutes.
4. Measure resistance of the (5) dimple motors and record.
5. Apply 9 Volts D.C. to dimple motors and record the time it takes to ignite.

Results: (Photographs and graphs, if any):

Motor No.	Resistance Before Heat	Resistance After Heat	Time to Fire 9 V D.C.
1	6.5 Ω	6.5 Ω	would not fire in 13 min.
2	7.4 Ω	8.1 Ω	would not fire in 5 min.
3	7.8 Ω	8.1 Ω	would not fire in 7 min.
4	6.5 Ω	6.5 Ω	would not fire in 5 min.
5	6.2 Ω	6.5 Ω	would not fire in 5 min.

Note: Heat = 205°C.

Conclusions:

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-16

JM	P.E.
FTM	S.H.
B	B.H.

2/28

Name of Test: Dimple Motor Temperature Test

Date of Test: 20 Feb. 61

Requested by: J. Madey

Performed by: J. H. Kauffman

Purpose of Test: To determine the temperature at which dimple motors ignite.

Description of Article Tested (Photographs, if any):

Dimple motors (5) type T-3E1
See attached DWG. DDA-2

Test Equipment (Photographs, if any):

Weston thermometers °C and °F
Hot-pac vac oven

Test Procedure:

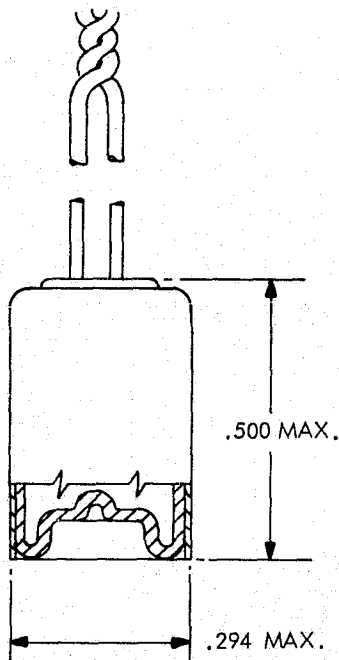
1. Place (5) motors in oven approx. 5" apart.
2. Place thermometer near center of motors.
3. Record time vs. temperature. 5 minute increments.
4. Start temperature (85° F. room) and raise temperature in 5° F incr.
5. Record time and temperature at which motors ignite.

Results: (Photographs and graphs, if any):

Graph and data included. Time vs. temperature.
The motors did not ignite - oven reached max. temperature.

Conclusions:

	T-3	T-7
Bridge Resistance	5 to 8 ohms	1000 to 10,000 ohms
Ignition Spot	Lead Styphnate	Lead Styphnate
Firing Energy	38.5 V., 1 Mfd.	55 V., .04 Mfd.
Movement	.1 in Against an 8 Pound Spring	



Dimple Motors T-3E1 and T-7E1 meet the following requirements:

- A. Contain all explosive gases during and after functioning when motion is limited by external means to 0.060".
- B. Function effectively throughout the temperature range of -65°F to $+165^{\circ}\text{F}$ after being subjected to:
 1. Transportation-Vibration Test MIL-STD-303
 2. Temperature & Humidity Cycle Test MIL-STD-304
 3. Storage
 - a. at -80°F for periods of at least 3 days
 - b. at $+165^{\circ}\text{F}$ and any condition of humidity for periods as long as 4 hours per day
 4. Shock which would produce 20,000 g's in any direction (currently being tested)
- C. Motors are not unsafe to handle or shall not have functioned after
 1. Jolt Test - MIL-STD-300
 2. Jumble Test - MIL-STD-301
- D. All materials used in contact with each other are compatible.
- E. Motor T-3E1 functions in approximately 1 millisecond.
- F. Motor T-7E1 functions in 30 ± 20 milliseconds.

DIMPLE MOTOR TEMPERATURE TEST20 February 1961

Time	°F	°C	Dimple Motors	Remarks
A.M. 8:25	85		OK	
30	88			
35	90			
40	92			
45	95			
50	102			
55	105			
9:00	110			
05	116			
10	120			
15	125			
20	130			
25	134			
30	138			
35	143			
40	146			
45	150			
50	152			
55	154			
10:00	158			
05	163			
10	169			
15	174			
20	178			
25	184			
30	187			
35	190			
40	192			
45	195			
50	200			
55	207			
11:00	212			
05	214			
10	217			
15	220			
20				OPEN OVEN TO INSTALL °C THERMO.
25		103		
30		105		HEAT TURNED OFF (LUNCH)

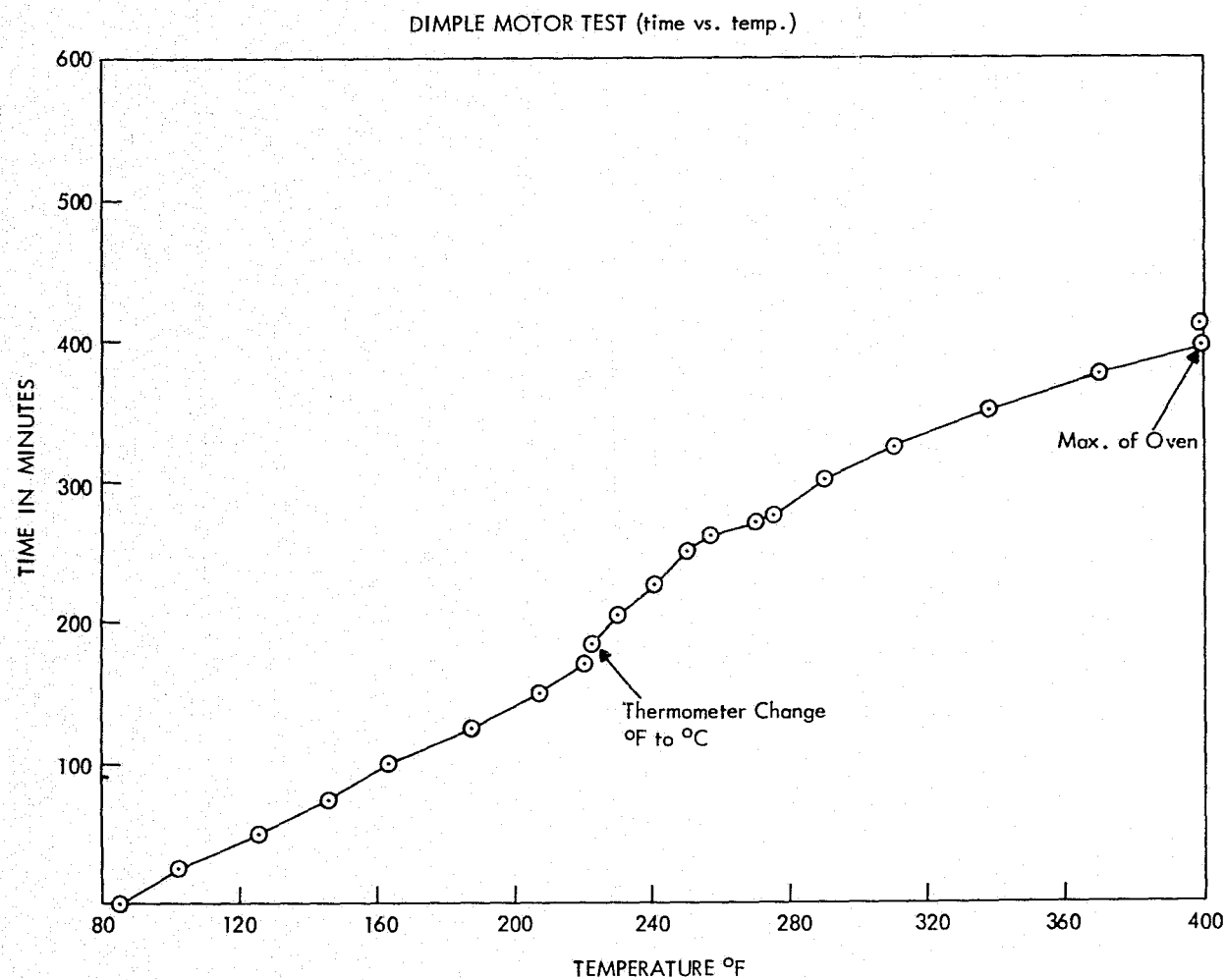
JHK

DIMPLE MOTOR TEMPERATURE TEST

20 February 1961

Time	°F	°C	Dimple Motors	Remarks
Noon 12:00		103	OK	HEAT TURNED ON
P.M. 12:15		104		
20		106		
25		108		
30		110		
35		112		
40		113		
45		115		
50		116		
55		117		
1:00		118		
05		119		
10		120		
15		121		
20		123		
25		125		
30		129		
35		132		
40		134		
45		135		
50		136		
55		139		
2:00		142		
05		144		
10		145		
15		146		
20		149		
25		152		
30		154		
35		156		
40		160		
45		163		
50		166		
55		168		
3:00		170		
05		175		
10		179		
15		183		

JHK



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 1500-3
ET P.E.
JM S.H.
FM B.H.
1/10/63

Name of Test: Dimple Motor Heat Compatibility S-3B

Date of Test: 8 Nov. 62

Requested by: E. W. Travis

Performed by: J. H. Kauffman

Purpose of Test: Determine maximum temperature dimple motors, Hercules DM 25A20, can withstand and still function properly.

Description of Article Tested (Photographs, if any):

Hercules Dimple Motor No. DM 25A-20

Test Equipment (Photographs, if any):

1. HP Power Supply Model 721 A
2. Blue 'M' Oven
3. Alinco Igniter Circuit Tester
4. Firing Box (MSB)

Test Procedure:

- I) 1. Install dimple motors (10) in yo-yo release bodies
2. Hook-up leads to terminal strip and run extension leads - 4' long.
3. Check resistance of squibs individually at ambient temp.
4. Raise temperature of oven to 80°C.
5. Install (1) in oven for 5 minutes.
6. Check resistance of (1) dimple motor.
7. Apply 19 VDC to (6) to see if it functions (fires)
8. Raise temperature to next conditions and do steps 5 thru 7 - soak time for each condition is 5 minutes.

Results:

See attached data

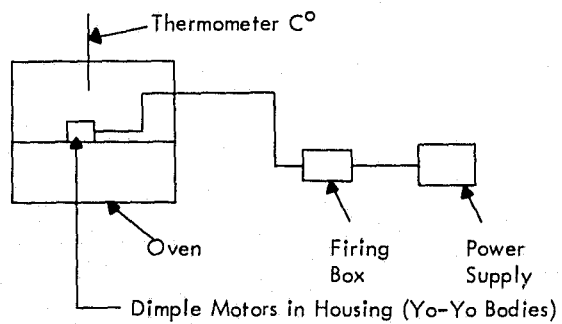
Conclusions:

Dimple motors functioned up to 140° C. At 180°C. dimple motors would not function. Use in Serb where temperature was around 60°C. maximum considered OK.

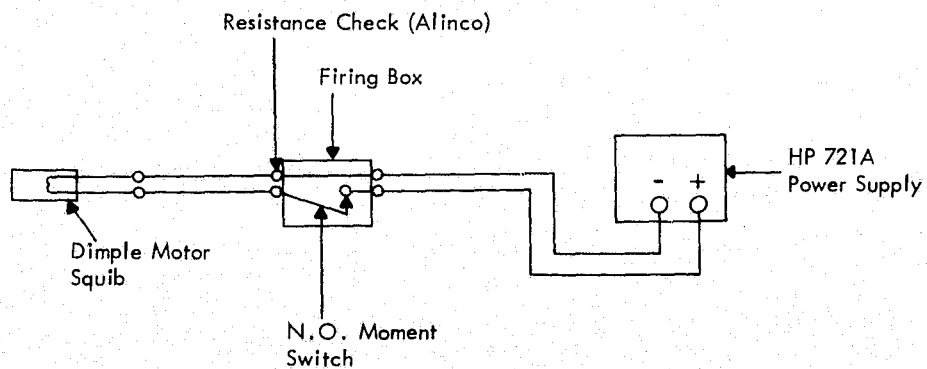
E. Travis
1-10-63

No.		Temperature - C°						
		80° C	90° C	100° C	110° C	120° C	140° C	180° C
1	6.57 Ω	6.61 Ω → Fired OK						
2	5.89 Ω		6.01 Ω → Fired OK					
3	5.67 Ω			5.78 Ω → Fired OK				
4	5.84 Ω				5.98 Ω → Fired OK			
5	4.17 Ω					4.39 Ω → Fired OK		
6	5.19 Ω						5.60 Ω → Fired OK	
7	5.82 Ω							6.18 *
8	5.72 Ω							
9	5.77 Ω							
10	6.07 Ω							

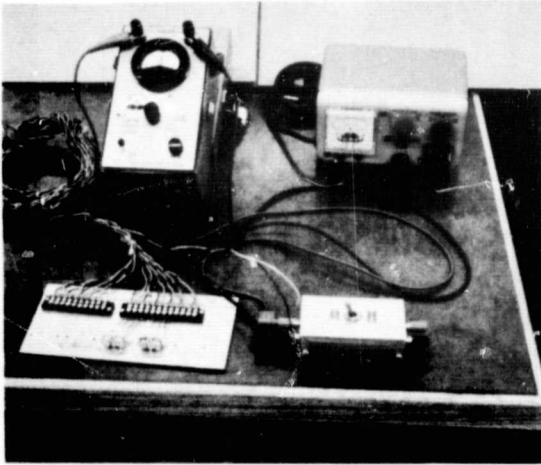
- NOTE: 1) All motors subjected to temperature of 80° C → 180° C for a total time of 1 hour.
 2) * None of the motors 7 thru 10 would fire?



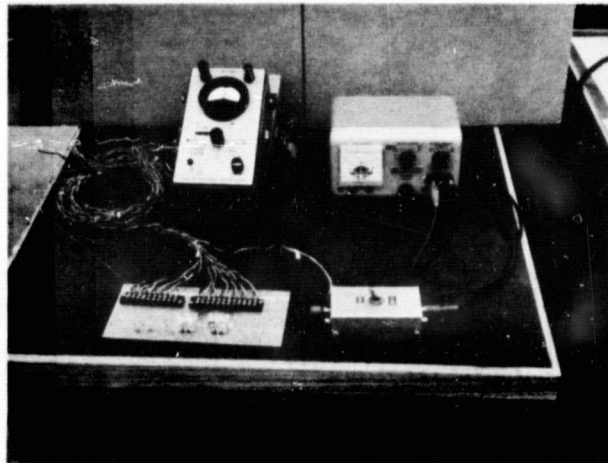
Block Diagram



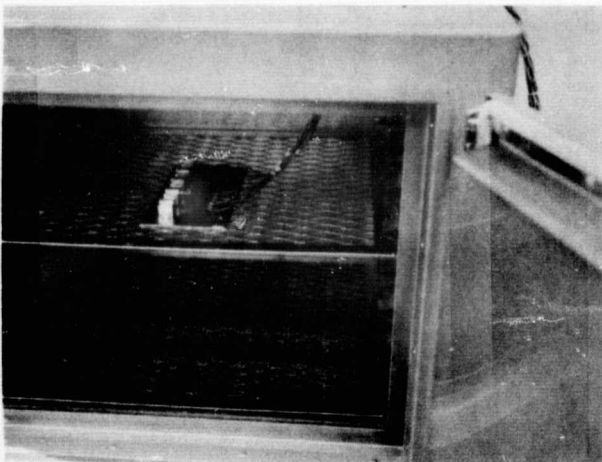
Firing Circuit



Checking Dimple Motor Resistance



Dimple Motor Firing Circuit



Dimple Motors in the
Temperature Chamber

VI. YO-YO TESTS S-3, S-3A, S-3B, AND S-3C

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 300-27

JM	P.E.
FTM	S.H.
B	B.H.

3/31

INFORMAL TEST REPORT

Name of Test: Yo-Yo De-Spin Timer Tests - Raymond #1060 3-1/4 to 4-1/4 G's

Date of Test: 24 March 61

Requested by: E. Travis

Performed by: R. D. Mason (T and E) for Mechanical Systems Branch - E. Travis

Purpose of Test: Qualification tests of timers for S-3 satellite

Description of Article Tested (Photographs, if any):

See attached sheets for description of Raymond timers.

Test Equipment (Photographs, if any):

Genisco centrifuge
Brush recorder
Stop watch

Test Procedure:

See attached sheet: S-3 timer tests

Timers were mounted to the centrifuge arm similar to attachment in S-3 payload. Each timer was monitored for actuation, total running time before #1 switch closure and delay time of switch #2. Each timer was also actuated and monitored while spinning at the equivalent of 165 RPM at 9.5 inches radius.

Results: (Photographs and graphs, if any):

1. Eight timers were tested per paragraphs (1) thru (5) of attached "S-3 Timer Tests".

Results: a. Six timers passed requirements.

- b. One timer exceeded the tolerance on total running time - 1200 sec. \pm 10%
Actual: 1380 sec.

- c. One timer failed to actuate during a test (but would not repeat itself) it actuated properly on subsequent repeated testing.

Conclusions:

2. Timer which failed to actuate once was returned to Raymond Engineering for rework.
3. Timer on high side of tolerance was adjusted to operate within tolerance.
4. Two timers were placed in prototype S-3 and will undergo vibration tests with prototype S-3 satellite. Results will be reported later.

Elmer W. Travis
March 28, 1961.

S-3 SATELLITE TIMERS

1. General Description

The timers used in the S-3 Energetic Particles Satellite are manufactured by Raymond Engineering Laboratory, Middletown, Conn., per their drawing No. 1060-90-18. They are standard Raymond No. 1060 timers modified to fit the S-3 requirements. The timing mechanism is "G" actuated by payload spin of 150 ± 15 rpm.

Listed below is the pertinent data on these timers:

- a. Weight: 442 grams each
- b. Quantity per Payload: Two
- c. "G" Actuated $3\frac{1}{4}$ to $4\frac{1}{4}$ G's
- d. Switch Actuation: 1200 seconds
- e. Two Spot Switches
- f. Switch #1 actuates 1 to 3 seconds before Switch #2 (when #2 switch closes - timers are removed from the circuit to prevent possible battery drain).
- g. Timing Mechanism: Spring Wound
- h. Timing Accuracy: $\pm 10\%$

2. Two timers will be located on opposite struts of the S-3 Satellite. The center of the "G" mass is approximately 9.5 inches from the spin axis. Assuming that the payload is spinning at the minimum rpm of 135 (150 ± 015), the force available to operate the timer will be approximately:

$$F = M^1 RW^2$$

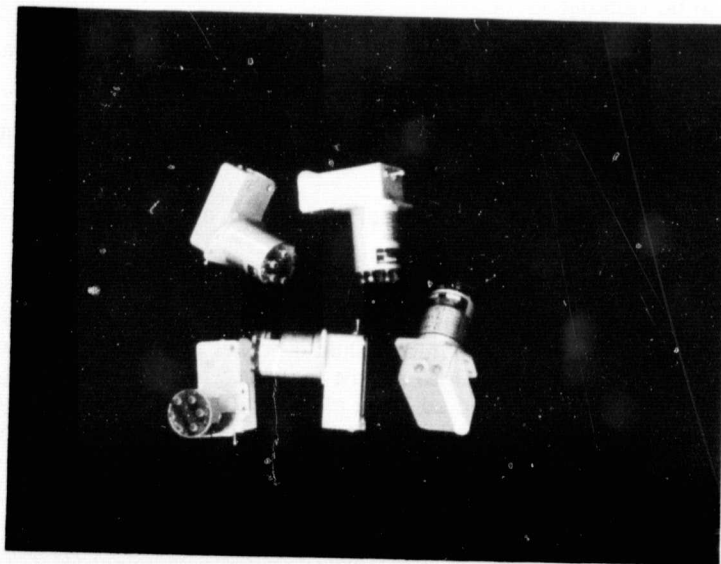
$$F = \frac{1}{32.2} \frac{(9.5)}{(12)} \left(\frac{135}{60} 2\pi \right)^2$$

$$F = 4.9 \text{ G's}$$

3. Two timers are wired as shown in the attached schematic dated 11-30-60. Upon payload spin-up to 150 ± 15 rpm, the timers are activated and the spring-wound clock begins to run. The #1 switch of the timer that closes first fires the yo-yo de-spin squibs. One to 3 seconds later the #2 switch in the timer closes and an open circuit exists between the yo-yo squibs and the power supply. This feature is included to prevent battery drain if a squib bridge wire should happen to remain intact after firing.

S-3 Timer Tests

1. Centrifuge - With timer mounted to centrifuge, find acceleration point which will initiate the timer. This can be accomplished by increasing the spin rate in steps and holding at each spin rate for approximately 3 minutes. After being sustained at each spin rate for 3 minutes, stop the centrifuge and check the timer visually for actuation. If actuated, the timer may be also be heard to be running.
2. Timer Actuation - Manually move the G weight and determine the time that acceleration must be sustained before the timer will not reset itself.
3. Switch Actuation - Determine the total time from initiation of the timer until closure of switch No. 1.
4. Delay Switch - Determine the delay time between closure of switch No. 1 and switch No. 2.
5. Record above data on separate sheets for a total of 10 timers.
6. Vibration - Two timers mounted in the S-3 Prototype shall pass prototype vibration tests without actuation of either timer. Timers should be set prior to vibration and visually checked immediately after vibration to insure that they were not actuated.
(Note: Timers should be disconnected from electrical power source during balancing prior to vibration since 150 rpm will actuate the timers which will subsequently initiate the yo-yo squibs.)



Raymond Timers

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 1400-3
XWM P.E.
JM S.H.
FTM B.H.

Name of Test: Yo-Yo Release Test (S-3A)

Date of Test: 25 Aug. 63

Requested by: Madey and Moyer

Performed by: J. H. Kauffman and J. Sween

Purpose of Test: To check release of yo-yo weights from yo-yo release bodies under 0 and 30 lb. cable tension.

Description of Article Tested (Photographs, if any):

S-3A yo-yo bodies and weights

Test Equipment (Photographs, if any):

1. Sanborn 2 Channel Recorder
2. HP power supply
3. Alinco squib tester
4. Squib firing switch
5. Micro-switch (weight release)
6. MSB spin-pitch rig

Test Procedure:

1. Mark and weigh each yo-yo weight.
2. Assemble body to S-3 cover.
3. Install squib in body and check squib resistance
4. Check release without cable attached 0# tension. (OK if weight falls out when squib is fired).
5. Check release with cable attached and tension of 30#. (OK if release (Micro-switch signal) is same as fire signal.)

Note: Fire signal and release signal was simultaneous -- as best as could be read on Sanborn Record. The above tests were performed using only 1 squib in the body.

Results:

All weights released according to test procedure 4 and 5.

Note: Dynamic Test - S-3A yo-yo assembly was tested on the S-52 DTU at Langley Research Center. See H. J. Cornille for film coverage.

Conclusions:

Based on the enclosed data, the weights should release regardless of angular velocity or cable tension.

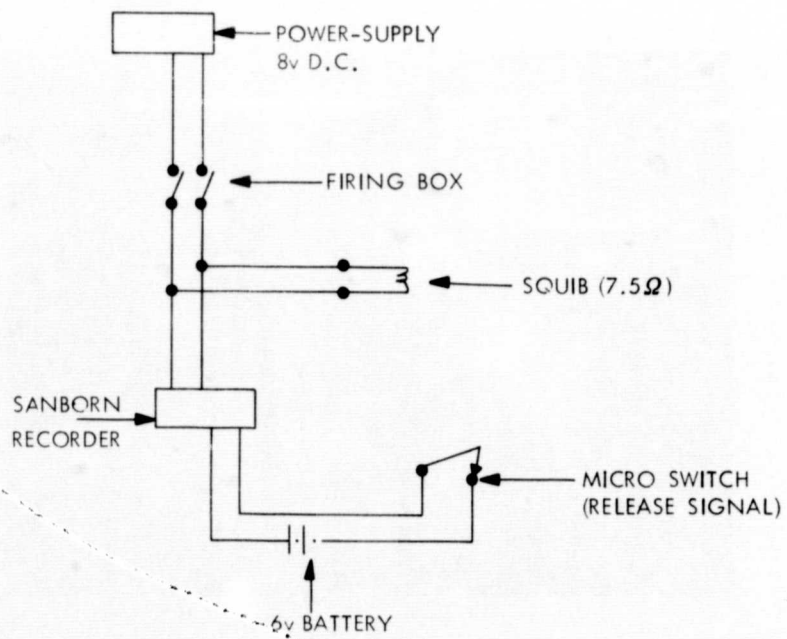
J. Madey

S-3A YO-YO RELEASE TEST

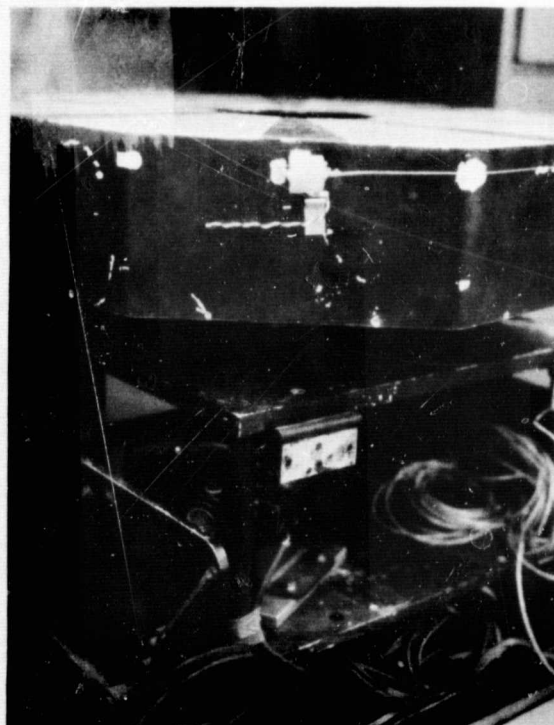
25 August 1962

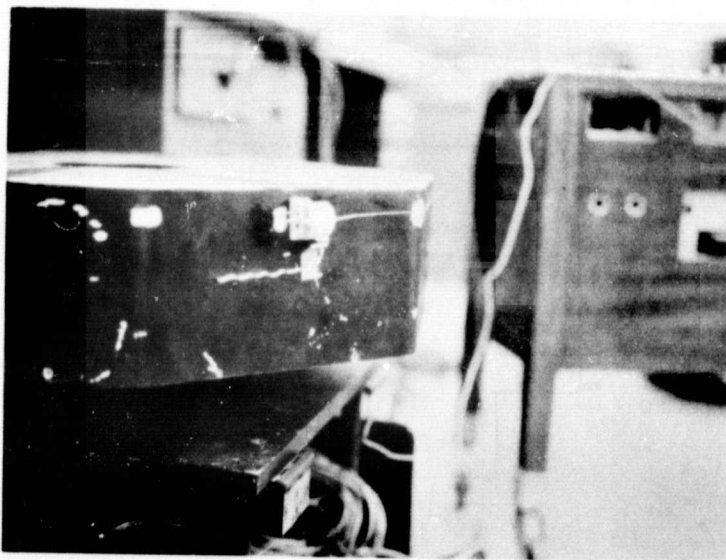
USING MODIFIED TENSIO METER - CABLE, END FITTING (2), NUTS (2) = 19.8 gms

[illegible]

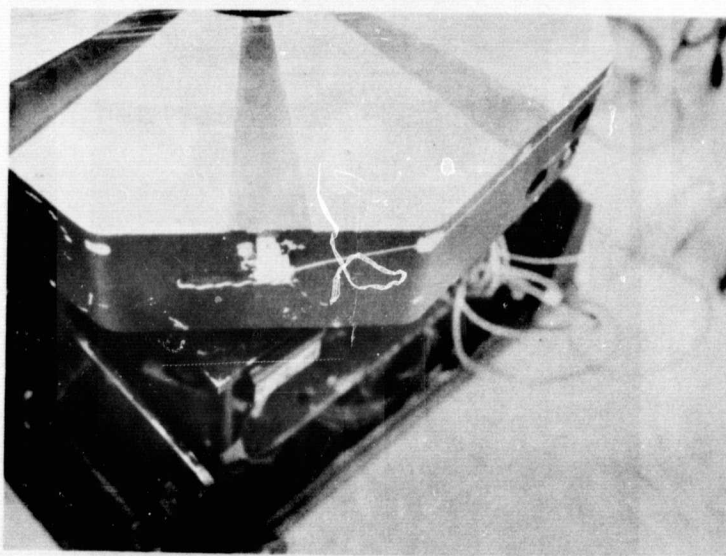


NOTE: MICRO SWITCH MOUNTED BELOW YO-YO BODY.





Test Set-up

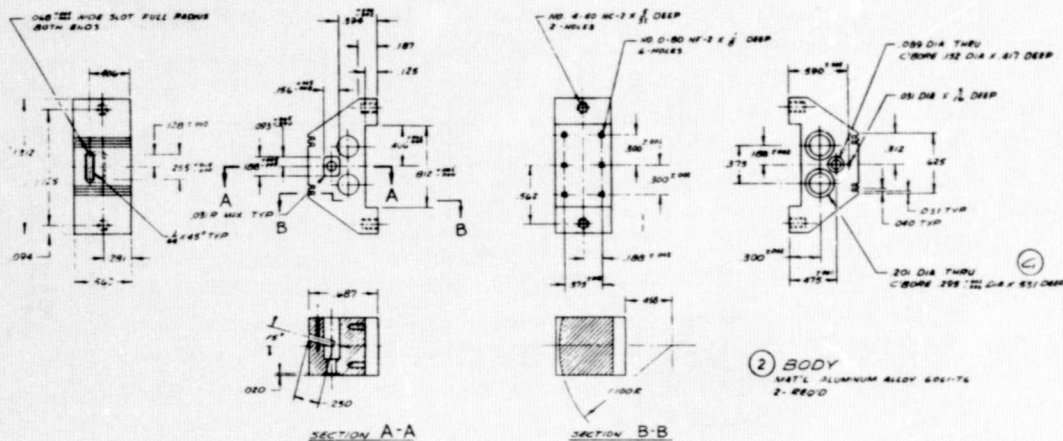


Test Set-up

SC-967-11
B-10-100

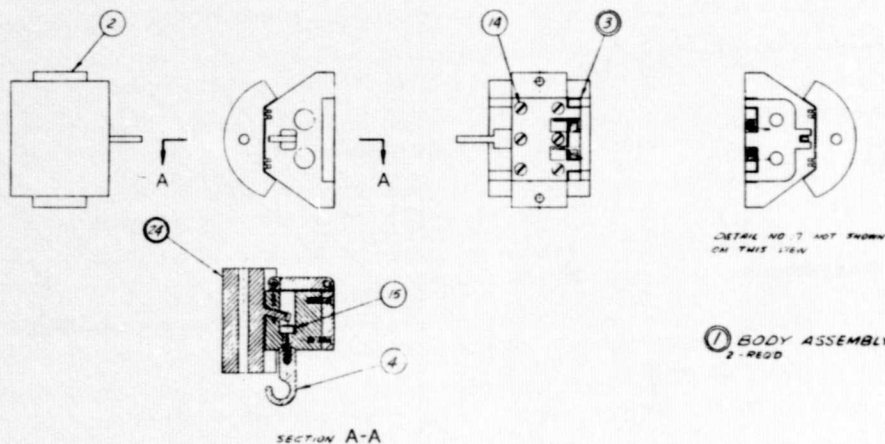


1994 4 0 4



NOTE: VALUETS OTHERWISE SPECIFIED
1. REMOVE ALL BRUISES AND SHARP EDGES

SCALE $\frac{3}{4}$
D59A-1006



DETAIL NO 7 NOT KNOWN
ON THIS STEIN

① BODY ASSEMBLY
2-REQD

SCALE $\frac{1}{8}$
0534-100

24	WARRANT	STEEL 1/2" X 1/2"	2
25	AND FITTING	STAINLESS STEEL TUBE 3/8"	2
22	RELEASE HOOK	ALUMINUM RECV 6061-T6	1
21	WING BOLT 1/2" X 1/2"	ALUMINUM RECV 6061-T6	1
20	STAINLESS PLATE 1/2" X 1/2"	STAINLESS STEEL 302	1
19	SCREW 1/2" X 1/2"	STAINLESS STEEL 302	1
18	SCREW 1/2" X 1/2"	STAINLESS STEEL 302	1
17	SCREW 1/2" X 1/2"	STAINLESS STEEL 302	1
16	WING BOLT 1/2" X 1/2"	ALUMINUM RECV 6061-T6	1
15	SCREW 1/2" X 1/2"	STAINLESS STEEL 302	1
14	SCREW 1/2" X 1/2"	STAINLESS STEEL 302	1
13	SCREW 1/2" X 1/2"	STAINLESS STEEL 302	1
12	WING BOLT 1/2" X 1/2"	ALUMINUM RECV 6061-T6	1
11	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
10	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
9	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
8	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
7	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
6	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
5	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
4	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
3	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
2	WIRE GUIDE	ALUMINUM RECV 6061-T6	1
1	WIRE GUIDE	ALUMINUM RECV 6061-T6	1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
J. Johnson 7-2-60
RTHK 12-2-60
H. J. 12-2-60
MFB 12-2-60

AIRCRAFT ENGINEERING SYSTEM BRANCH, AIRLINE TEST DIVISION

DE-SPIN DEVICE
ASSEMBLY AND DETAILS

SCALE $\frac{1}{8}$
0534-100

9

41 D53A-1006

VII - MISCELLANEOUS TESTS S-3-S-3A-S-3B

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. _____
LS P.E.
S.H.
B.H.

Name of Test: Solar Array Aspect Test (S-3)

Date of Test: 20 to 26 July, 61

Requested by: Luther W. Slifer, Jr.

Performed by: Kauffman, Krueger and Slifer.

Purpose of Test: To determine S-3 solar array power output as a function of spin-axis to sunline angle.

Description of Article Tested (Photographs, if any):

S-3 prototype with four S-3 flight paddles installed.
See photo attached.

Test Equipment (Photographs, if any):

Spin-rig.
Sanborn recorder (8 channels).
Unmounted (control) solar paddle.
Voltmeters, ammeters, batteries and accessories.

Test Procedure:

The S-3 prototype satellite was mounted upright on the spin rig. The four flight solar paddles were installed and the satellite was spun up to approximate satellite flight rotation however wind conditions prevented a constant rotation speed. Recorder calibrations were performed for rotation speed, pitch angle, paddle voltage and paddle current. The control paddle output was read and recorded. The time was recorded and the recorder was started. The satellite, while spinning, was pitched by hand in 5° intervals from 0° up to 90° from the vertical. New output readings were obtained from the control paddle and the pitch was then decreased in 5° intervals from 90° down to 0° from the vertical. The time, rotation speed and control paddle outputs were again recorded. The test was discontinued because of approaching adverse weather conditions.

The test was resumed with the satellite mounted in the inverted position. The above procedure was repeated through the run from 0° to 90°, however, excessive noise on the records resulted in poor resolution and the data were considered inadequate.

The test procedure was repeated with the satellite inverted after the noise difficulties were corrected. Complete runs were achieved. A final calibration for rotation angle was performed.

Results:

Table I presents the summary of the test conditions.

Detailed results will be forthcoming.

Conclusions:

These tests essentially confirmed the theoretical results presented by Dr. Fedor in his memo to the Branch Files titled "Theoretical Average Available Power from S-3 Solar Paddles" dated 25 July 1961. The shapes of the power curves were very much the same and the differences in magnitudes were within the expected range.

Recommendations:

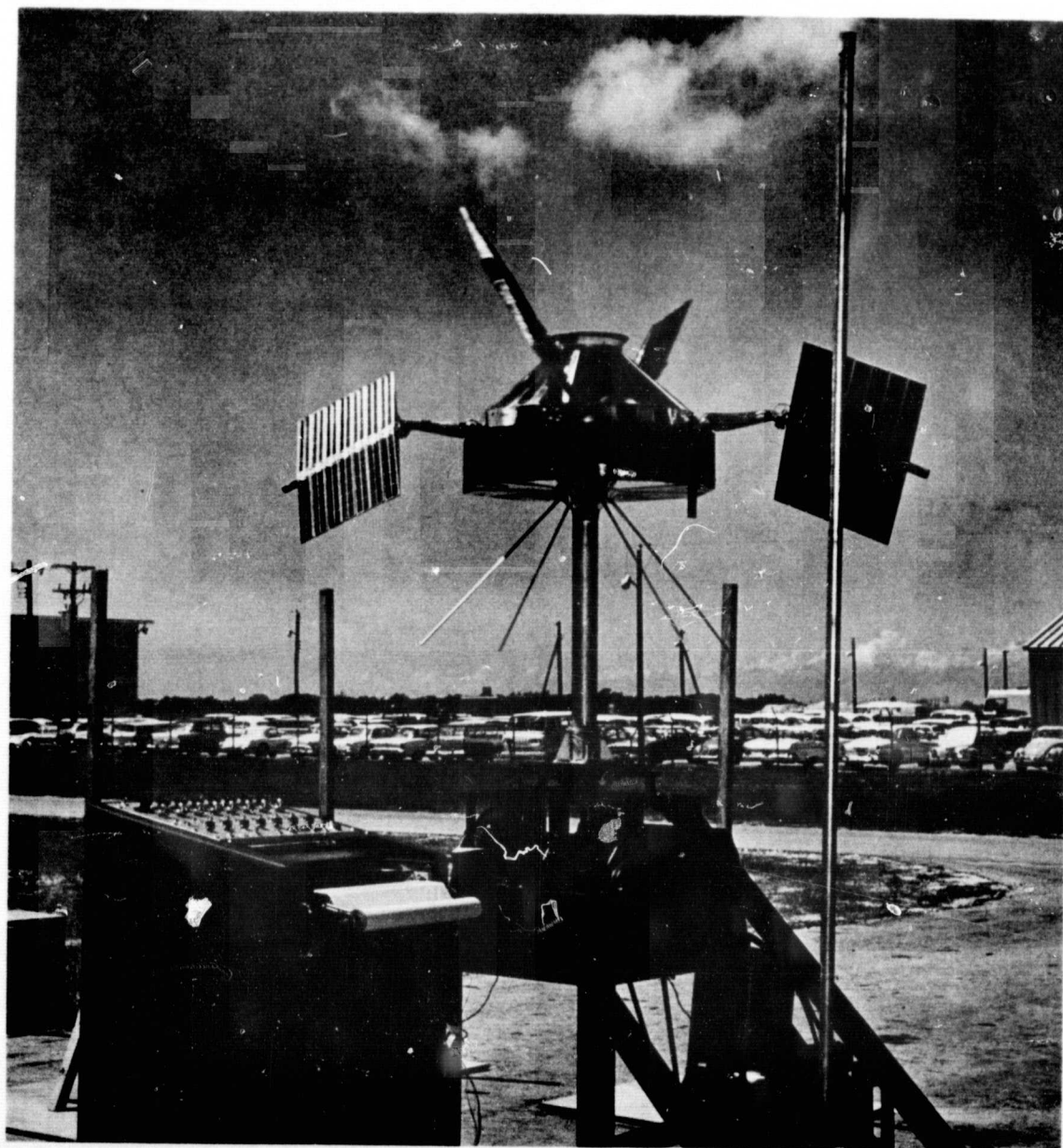
These tests and test results lead to the following recommendations for future tests:

1. It is recommended that more sophisticated measurements of solar input be made.
2. It is recommended that direct measurements of sunline to spin-axis angle be made.
3. It is recommended that a permanent "block-box" housing be constructed so that reflection and stray light inputs can be better illuminated.
4. It is recommended that, in so far as is possible, the paddle output be measured through the use of telemetered performance parameters with all systems operating.

Luther W. Slifer, Jr.

TABLE I
S-3 SOLAR PADDLE ASPECT TEST CONDITIONS

	Run 1	Run 2	Run 3	Run 3
DATE	7/22/61	7/22/61	7/26/61	7/26/61
TIME (START) EST	12:50		1:25	
CONTROL PADDLE CURRENT	670 ma	676 ma	588 ma	578 ma
PITCH ANGLE RANGE	0° - 90°	90° - 0°	0° - 90°	90° - 0°
CONTROL PADDLE CURRENT	676 ma	635 ma	578 ma	560 ma
TIME (END) EST		1:30		1:53
PAYLOAD POSITION	Upright	Upright	Inverted	Inverted



Test Set-up

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

File No. 1400-2
XWM P.E.
JM S.H.
B B.H.

INFORMAL TEST REPORT

Name of Tests: Solar Paddle Shadow and Systems Check

Date of Test: 18 June to 22 June 62

Performed by: J. H. Kauffman, A. J. Pierro, X. W. Moyer, R. Sullivan, EMR personnel, NASA
at Litton

Purpose of Test: Primary: Check and plot solar paddle output versus aspect.
Secondary: Check optical aspect readings vs. measured aspect

Description of Article Tested (Photographs, if any):

S-3A flight unit and flight solar paddles.
All tests run at EMR in "Hot-House"

Test Equipment (Photographs, if any):

See Photos
MSB Spin Pitch Table

Test Procedure:

See attached list for runs in upright position.

1. Install payload on spin table
2. Rotate payload at 12 rpm and transmit with payload turned on.
3. Pitch payload as per instruction of H. Meyerson for spin axis to sun aspect.

Results: (Photographs and graphs, if any):

Results will be reduced from tapes recorded during test by NASA at Litton.

Conclusions:

TESTS

19 June 1962

<u>TEST NO.</u>	<u>ASPECT ANGLE *</u>
1	19°
2	80°
3	39°
4	39°
5	54°

* Aspect angle readings obtained from solar aspect sensor.

21 June 1962

<u>TEST NO.</u>	<u>ASPECT ANGLE</u>	<u>PITCH TABLE ANGLE</u>
1	31°	5°
2	43°	37.5°
3	54°	56°
4	65°	69°
5	75°	80°
6	77°	90°
7	24°	40°
8	16°	29°
9	7°	19°
10	54°	71°

LOG

18 June 1962 Monday

Upright position

Payload installed on spin-pitch table without top and bottom covers. Solar paddles installed and hooked-up. Payload turned-on to transmit - malfunction - payload removed and placed inside to diagnose trouble. Encoder card not functioning - removed and replaced. Note: Payload and packages extremely warm - due to sun.

19 June 1962 Tuesday

Upright position

Install squibs for yo-yo release and wired to proper pins. Installed payload on spin-pitch table with covers on. Installed solar paddles and turned payload on to transmit. Ran tests 1 - 5. Lots of haze and clouds during these tests. Removed payload and secured test at 4:00 P.M. Note: Wall temp. inside hot-house - 60° C.

20 June 1962 Wednesday

Rain - No Test -

21 June 1962 Thursday

Upright position

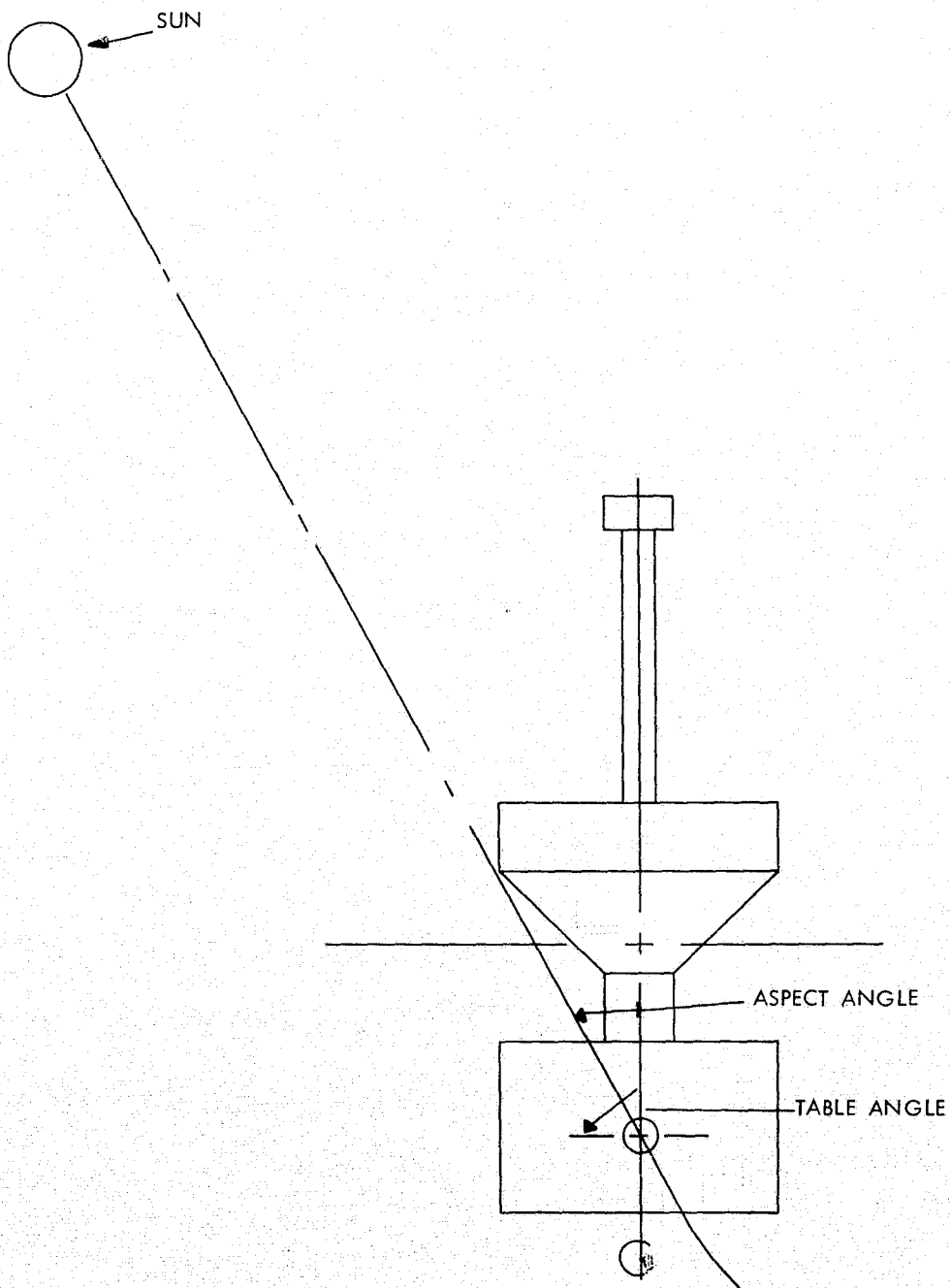
Payload installed on spin-pitch table. Solar paddles installed and payload turned on to transmit. Tests 1 thru 10 - lots of haze and clouds during tests. Removed payload and secured the test.

22 June 1962 Friday

Inverted position

Installed payload and solar paddles. No tests were run due to extreme haze and clouds. Removed payload and secured at 1:30 P.M. due to threat of rain -

Test in inverted position may be run at a later date if possible.



SPIN DIRECTION C. CLOCKWISE
AT 12 RPM

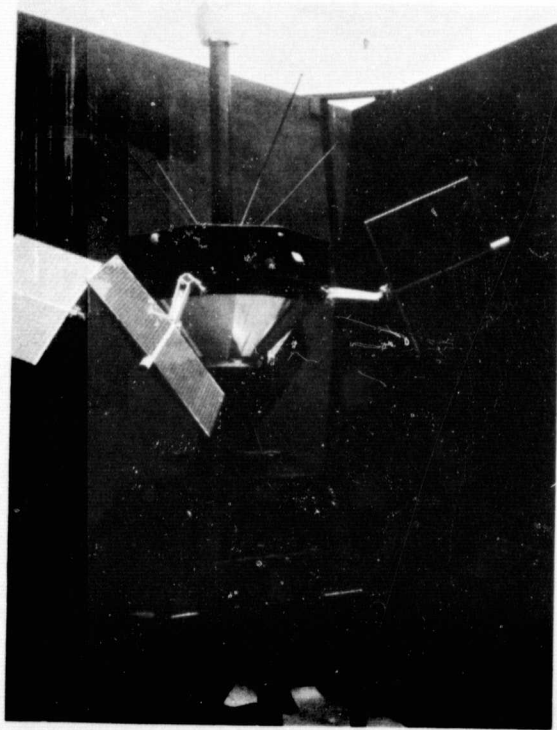


Photo No. 1

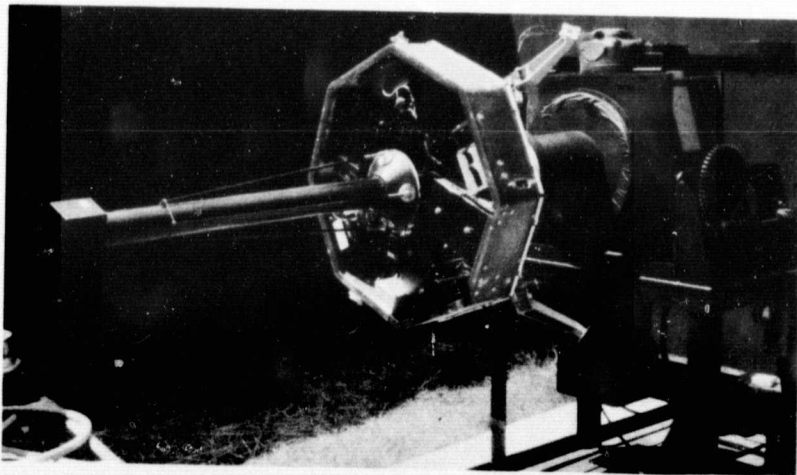


Photo No. 2

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKETS DIVISION

File No. _____
E.T. P.E.
J.M. S.H.
F.M. B.H.

INFORMAL TEST REPORT

TEST: DESIGN FAILURE INVESTIGATION, RESULTS OF S-3B

1. ABSTRACT

The SERB failure analysis program is essentially complete. Results do not indicate the cause of the spacecraft's de-spin system failure. However areas for improvement were uncovered in design, system philosophy, and test procedure.

2. INTRODUCTION

Due to the failure of the SERB "yo-yo" de-spin system, an investigation was undertaken to determine the cause thereof. A three-phase approach was taken: (1) component tests; (2) system tests; and (3) critical analysis of design philosophy. Participants in the investigation were Spacecraft Integration and Sounding Rocket Division, Spacecraft Technology Division, and Test and Evaluation Division. Assistance was obtained from various component manufacturers.

3. BACKGROUND

The "yo-yo" de-spin system employed on the SERB spacecraft was mechanically identical to that used on the Explorer XIV payload and similar to that successfully used on Explorer XII. The wiring of the SERB de-spin unit was slightly different than that of Explorers XII and XIV. Hercules DM25A-20 dimple motors were used on SERB as on Explorer XIV. Modified Raymond Engineering Laboratory No. 1060 "G" timers were utilized on all three spacecraft.

Temperature profiles and other launch and injection environmental parameters were similar to those encountered by Explorers XII and XIV, the single exception being a 10-15 cps, 13 g, transverse vibration due to flexure of a gyro mount in the Delta first stage guidance. This vibration was not experienced by Explorer XII. Dynamic testing during the SERB development program did not include transverse vibration at these levels.

The sequence of events involving the de-spin system was the same on all three spacecraft and is summarized here:

t = -16 sec. (850 seconds after launch)	Spin-up X-248 activating "g" timers
t = 0	Ignition of X-248
t = +41	X-248 burn-out
t = 1198 ± 120	First switch in timer closes, firing dimple motors from spacecraft batteries and releasing "yo-yo" weights.
t = 1 to 3 after above	Normally closed switch in timer opens, thereby breaking the circuit between dimple motors and batteries.

4. RESULTS - GENERAL

Component tests of dimple motors, timers, and the "yo-yo" mechanical system did not produce any evidence to which the SERB failure could be attributed.

System tests were normal with the exception of a mechanical failure on one "yo-yo" body in one instance. However, this failure was a direct result of faulty assembly and is not considered pertinent to the SERB failure. Although not related to the objective of the investigation, it was noted that firing of the dimple motors turned the spacecraft off when the battery charge was low. (Firing of dimple motors dropped spacecraft battery voltage below undervoltage lock-out.)

Further analysis of this phenomenon is being undertaken by the Battery Section of the Space Power Technology Branch.

Analysis of the system also showed a lack of redundancy in the system wiring. Also, wiring was carried through some components and connectors which was unnecessary and added to the number of possible problem areas.

In keeping with the general policy on Project SERB, comprehensive check-out of the de-spin system after shipment to the field was not performed.

5. CONCLUSIONS

It is felt that the results of the SERB failure analysis program do not offer conclusive evidence as to the reason for the SERB de-spin malfunction. Several hypotheses were made by various project personnel; none could be proven.

However, several possible problem areas in the SERB C unit and GSFC future satellites were uncovered as a direct result of this investigation. It was noted that the S-3B de-spin system was not completely redundant. Also, the routing of the system wiring did not adhere to standard explosive system philosophy - directly from the batteries to the timers to the explosive dimple motors. It was also noted that in two out of four instances of system checks of the de-spin system, the firing of the dimple motors dropped the spacecraft main battery voltage below the undervoltage lock-out point - subsequently turning the payload off until the eight-hour re-cycle timer turn on. It was also noted that the de-spin system check run at GSFC prior to shipment to the Cape was not a complete system check - the test panel and plug were used rather than the actual flight turn-on plug.

6. RECOMMENDATIONS

Based on this study the following is recommended prior to launch of the S-3C spacecraft.

- a. Complete de-spin system check without external connections to satellite (spacecraft turned on, timers actuated, dimple motors fired).
- b. Direct redundant wiring from batteries to "G" timers to explosive dimple motors.
- c. Installation of current limiting resistors in parallel with each dimple motor to eliminate possibility of a shorted dimple motor from shorting the system.
- d. De-spin subsystem check on Gantry in the event of removal of the top cover of the spacecraft to insure that no damage to wiring has occurred and a subsystem electrical checkout after reassembly.
- e. Further study to determine if firing the de-spin system after 35 minutes of payload operation causes a momentary voltage drop which is marginal with respect to operation of the undervoltage detector.

Elmer W. Travis

SERB SPACECRAFT (S-3B)
Post Mortem Vibration Levels

1. SINE SWEEP

<u>Axis</u>	<u>Frequency CPS</u>	<u>Test Duration</u>	<u>Acceleration g. 0 to peak</u>
Thrust	5 - 50	1.66	2.3
Z-Z Axis	50 - 500	1.66	10.7
	500 - 2000	1.00	21.
	2000 - 3000	0.30	54.
	3000 - 5000	<u>0.36</u>	21.
Total 5 min.			
Lateral	5 - 50	1.66	0.9
(X-X Axis)	50 - 500	1.66	2.1
and (Y-Y Axis)	500 - 2000	1.00	4.2
	2000 - 5000	<u>.66</u>	17.
Total 5 min.			

2. RANDOM MOTION

Thrust	20 - 2000	4 min	11.5 g-rms
Z-Z Axis			0.07 g ² /cps
Lateral	20 - 2000	4 each	11.5 g-rms
X-X		<u>axis</u>	0.07 g ² /cps
Y-Y axis			
Total 12 min.			

3. COMBUSTION RESONANCE

Thrust Z-Z	550 - 650	(10°/min sweep rate)	±86.0 g 0-peak
Lateral X-X Y-Y	550 - 650		±14.5 g 0-peak

4. LOW FREQUENCY

Thrust Axis	10 - 15 cps	1 min. duration	*4 to 10 g peak
Z-Z			
Lateral Axis	10 - 15 cps	1 min. duration	*4 to 10 g peak
X-X			
Y-Y			

*Limit of shaker

SERB SATELLITE "G" TIMER DESCRIPTION AND DATA**1. GENERAL DESCRIPTION**

The timers used in the SERB spacecraft were manufactured by the Raymond Engineering Laboratory, Middletown, Connecticut, per their Drawing No. 1060-91-11. They are standard Raymond No. 1060 timers modified to fit the S-3 type spacecraft requirements. The timing mechanism is "G" actuated by payload spin of 150 ± 15 rpm.

Listed below is the pertinent data on these timers:

- a. Weight 442 grams each
- b. Quantity per payload - two
- c. "G" actuated $3\frac{1}{4}$ to $4\frac{1}{4}$ G's.
- d. Switch actuation: 1200 seconds
- e. Two Spot Switches
- f. Switch #1 actuates 1 to 3 seconds before Switch #2 (when #2 switch closes - timers and yo-yo explosives are removed from the circuit to prevent possible battery drain.)
- g. Timing mechanism - spring wound
- h. Timing accuracy - $\pm 10\%$

2. Two timers were located on opposite struts of the SERB satellite. The center of the "G" mass is 9.5 inches from the spin axis. Assuming that the payload is spinning at the minimum rpm of 135 (150 ± 15), the force available to operate each timer will be approximately:

$$F = M^1 RW^2$$

$$F = \frac{1}{32.2} \frac{(9.5)}{(12)} \frac{(135 \frac{2}{60})^2}{60}$$

$$F = 4.9 \text{ G's}$$

3. The two timers were wired as shown on GSFC Dwg. GR-S3B-1005383. Upon spacecraft - X-248 spin-up to 150 rpm at 850 seconds after launch, the timers are activated and the spring wound clock begins to run. The #1 switch of the timer that closes first fires the yo-yo de-spin squibs. One to three seconds later the #2 switch in the timer closes and an open circuit exists between the yo-yo squibs and the power supply. This feature prevents battery drain if a squib bridge wire should short after firing.

COMPONENT AND SYSTEMS TESTS COMPLETEDComponent Tests

A brief summary of the component testing is listed below:

A. De-spin Timers (two from SERB lot)

1. Operation under combined X-248 spin and thrust acceleration (7.6 G and 12 G ignition) (7.6 G and 30 G burnout) - OK

2. Acceleration (G's) necessary to arm timers and switch closure checks - armed between 3-1/4 to 4 G's - switches OK

3. Vibration - Prototype sine, random, combustion resonance. Low frequency - 3 direction transverse resonance dwell tests - OK

4. Temperature - Operation at 23°C to 75°C. OK

B. Yo-Yo De-spin Bodies. Weights and Wire

1. Vibration - Prototype sine, random, combustion resonance. Low frequency transverse - 3 directions. OK

2. Miscellaneous vibration runs dwelling at various structural resonances in an attempt to induce failure or door opening. OK

C. De-spin Dimple Motors (explosive)

1. Functional tests from 80°C to 180°C. OK

2. Determine cook-off temperature - above 180°C functioning was very erratic - no cook-off up to 250°C. Test stopped.

Systems Tests

The following systems tests were conducted utilizing a complete spacecraft structure with de-spin system identical to the S-3B flight unit. This included batteries, "G" timers, program switch, recycle timer, regulator converter, turn on plug and dummy weighted experiments.

A. Vibration - Prototype sine, random and combustion resonance. Low frequency transverse - 3 directions.

After the sine and random, after the combustion resonance, and after the low frequency transverse tests the de-spin timers were manually initiated. The dimple motors all functioned properly.

B. Simulated Heat Shield Heating, Spin Acceleration and Aerodynamic Heating in Vacuum.

The test set up description and temperature profile is shown on Enclosures 4 and 5. The "G" timers armed on spin up of 150 rpm. The yo-yo's were both released and system performance was satisfactory.

**Simulated Heat Shield Heating, Spin Acceleration,
Aerodynamic Heating in Vacuum**

Test Unit - Spacecraft structure with complete live de-spin system including batteries, timers, program switch, regulator converter, turn on plug, dimple motors, etc. All other components dummy weighted.

Spin Rate - 150 rpm

Vacuum - 5 mm Hg.

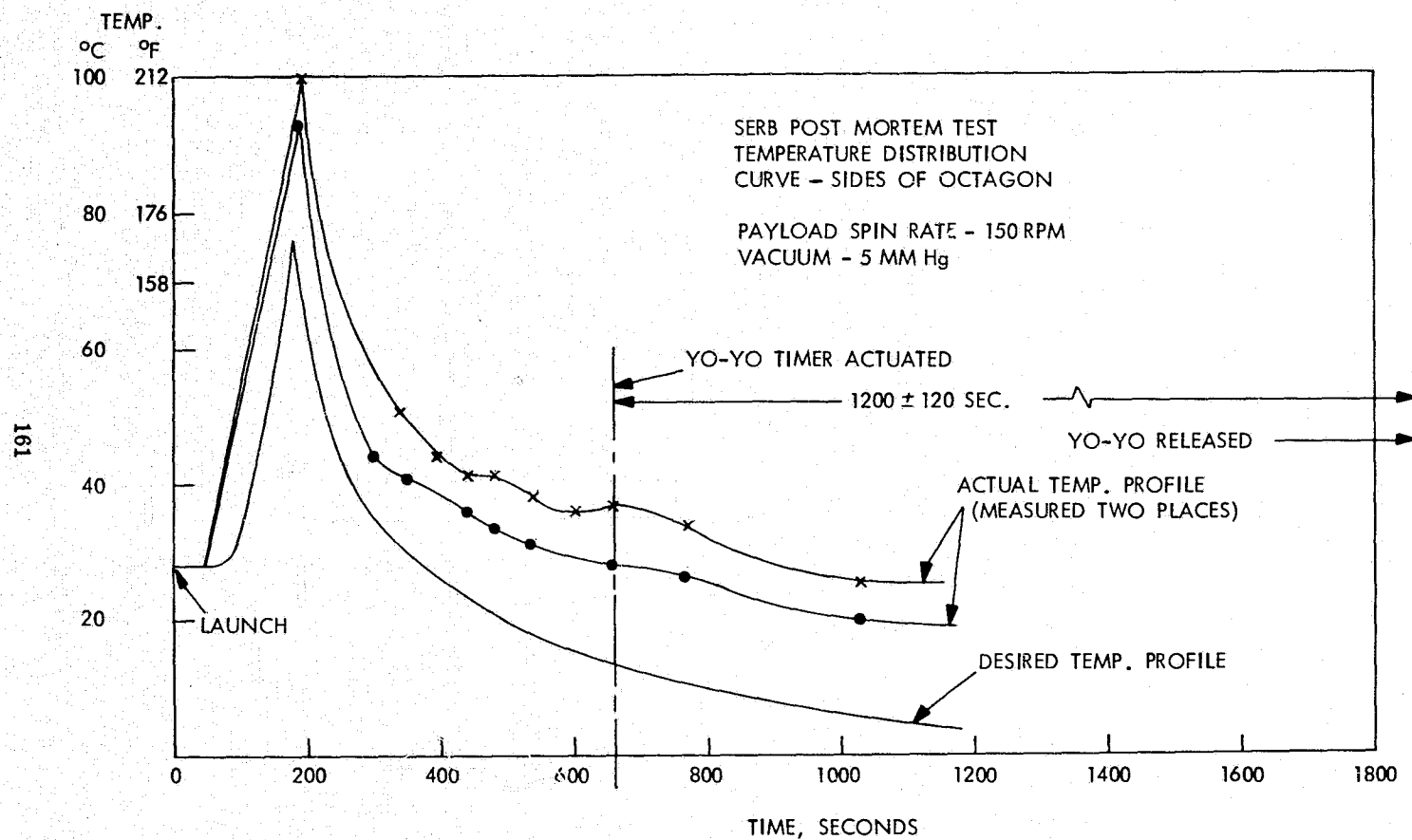
Test Duration - 1800 seconds plus

Octagon Wall Temperature - Time - temperature profile controlled by mercury ARC lamps placed around periphery of spacecraft in vacuum chamber.

De-spin System - Complete with explosives, weights, etc. Yo-yo bodies restrained after a few inches of movement to prevent damage to test facilities.

Results

Examination after the test showed that the arrested yo-yo weights had released satisfactorily. The heating environment was more severe than desired on the octagon wall but the de-spin units in the vicinity of the explosive dimple motors reached only 34°C.



MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION
INFORMAL TEST REPORT

File No. 1500-1
10-5-62 EWT P.E.
10-8-62 JM S.H.
FTM B.H.

Name of Test: Solar Paddle Erection Test (S-3B)

Date of Test: 15 Sept. 62

Requested by: H. J. Cornille

Performed by: F. LeDoux - J. Kauffman - F. Kocher - J. Wall - H. J. Cornille - R. W. Forsythe

Purpose of Test: Acceptance test of solar paddle structure

Description of Article Tested (Photographs, if any):

S-3B structural model
S-3B paddle arm and hinges
S-3 weighted spars
X-248 dummy can

Test Equipment (Photographs, if any):

1. MSB Spin Table
2. Horex cutters
3. Sanborn 2 channel recorder

Test Procedure:

1. Spin Table.
 - a. Install de-clutch mechanism to spin table.
 - b. Install X-248 dummy can to table and adjust run-out at payload mounting flange. Bond hold-down cradles and cutter holder to can.
 - c. Install rpm pot to spin shaft.
 - d. Install payload.
2. S-3B Structural Model
 - a. Install lead to spars to bring weight to 5.32#
 - b. Install S-3B hinges, arms and weighted spars to S-3B structural model.
3. Check moment of inertia of system - 3.00 slug-ft² with paddles folded.
4. Proceed with test at Bld. #4 in accordance with P.E. verbal instructions and run sheet 1 and 2.
 - a. On each run a nylon cord was employed to hold down the paddles and a Horex cutter released the paddles. (Cut the nylon cord.)
 - b. RPM was recorded on one channel and the release (fire) signal was on the other channel.
 - c. RPM checked before each release.See SK-1 for rpm pot info. and typical record.
See SH-3 R. W. Forsythe's no 'G' curve.

Note: RPM's on sheet 1 and 2 are corrected as of 17 Sept. 1962

Results:

Film coverage on runs 1 thru 5 (H. J. Cornille)
See attached report

Conclusions:

See attached report dtd. 16 Sept. 1962 title (Serb Solar Paddle Arm Structural Tests).

SERB SOLAR PADDLE ARM STRUCTURAL TESTS

September 16, 1962

Introduction

Acceptance tests of the SERB solar paddle structure were conducted on September 15, 1962. The tests were conducted by members of the Mechanical Systems Branch in Building 4 of the center. The MSB variable speed spin table was employed. A Sanborn Recorder was used to record spin rates.

Background

Since the SERB solar array geometry differs from that of the Explorer XII, new structural hardware is required. Although the design is similar to the Explorer XII, an acceptance test was required to verify the analytical solution to the design.

Present plans call for the SERB orbital spin ratio to be 10 rpm, although the possibility exists that this figure may be adjusted downward to as low as 5 rpm.

The estimated mass moment of inertia of the SERB and spent X-248 motor with paddles folded is 3.00 slug-ft². With paddles open the mass moment of inertia is estimated at 6.11 slug-ft².

Applying conservation of momentum and a spin rate of 10 rpm after paddle erection, it is found that the nominal spin rate at paddle erection will be 20.4 rpm.

Impressing a 10% factor for error in the X-248 spin rate, and another 5% factor for variations in the yo-yo de-spin mechanism due to uncertain knowledge of the mass moment of inertia of the spent X-248, the maximum spin rate to be expected at paddle erection is 23.5 rpm.

If 5 rpm is chosen as the orbital spin rate, the nominal spin rate at paddle erection will be 10.2 rpm, and could vary as low as 8.67 rpm. Since it is only necessary to overcome static friction in the bearings to erect the paddles in space no springs are employed in the design. Another objective of the tests therefore was a determination of the lowest spin rate at which the paddles will erect and lock in position. Should the orbital spin rate of 5 rpm be decided upon, careful consideration will have to be given to the addition of erection springs.

Method

A method devised for simulation of paddle deployment in "zero g" was employed. This method was successfully employed in the testing of the Ariel I and S-52 appendages. The system consists of overspinning to counteract the effects of gravity and give the solar paddle arm the same kinetic energy at lock-in that would have been attained under "zero g" conditions.

The arms were weighted with lead to produce the same weight as the flight paddles. Mass moment of inertia of the test fixture was adjusted to 3.0 slug-ft² with the paddles folded.

The paddles were mounted to a partial payload structure, having a dynamic response similar to flight payload.

A nylon cord was used to fold the paddles down along the simulated X-248 in the same way as will be done in the actual flight.

The paddles were released by the detonation of a guillotine through which the nylon cord passed.

Test Sequence

Notation:

w_0 = test speed at paddle erection

w_0^1 = simulated speed at paddle erection in "zero g" field

w_+ = speed after paddle erection

Test No. 1

w_0 = 55.2 rpm

w_0^1 = 20.0 rpm

w_+ = 25.9 rpm

w_+/w_0 = 0.469

Notes: Normal erection and lock-in. Spin ratio shows inertia ratio to be slightly different from expected flight conditions.

Test No. 2

w_0 = 52.8 rpm

w_0^1 = 12.2 rpm

w_+ = 25.0 rpm

w_+/w_0 = 0.474

Notes: One paddle did not fully lock-in, others normal.

Test No. 3

w_0 = 59.5 rpm

w_0^1 = 30.2 rpm

w_+ = 27.4 rpm

w_+/w_0 = 0.461

Notes: Normal erection and lock-in.

Test No. 4

w_0 = 64.5 rpm

w_0^1 = 39.3 rpm

w_+ = 29.3 rpm

w_+/w_0 = 0.454

Notes: Normal erection and lock-in.

Test No. 5

$$W_0 = 50.4 \text{ rpm}$$

$$W_0^1 = 0 \text{ rpm}$$

Notes: Paddles failed to lock-in.

Test No. 6

$$W_0 = 51.1 \text{ rpm}$$

$$W_0^1 = 0 \text{ rpm}$$

Notes: Paddles failed to lock-in.

Test No. 7

$$W_0 = 51.6 \text{ rpm}$$

$$W_0^1 = 4.2 \text{ rpm}$$

Notes: Paddles failed to lock-in.

Test No. 8

$$W_0 = 53.5 \text{ rpm}$$

$$W_0^1 = 14.9 \text{ rpm}$$

$$W_+ = 28.1 \text{ rpm}$$

$$W_+/W_0 = 0.526$$

Notes: Normal erection and lock-in.

Test No. 9

$$W_0 = 53.2 \text{ rpm}$$

$$W_0^1 = 13.9 \text{ rpm}$$

$$W_+ = 25.1 \text{ rpm}$$

$$W_+/W_0 = 0.472$$

Notes: Normal erection and lock-in.

Test No. 10

$$W_0 = 52.8 \text{ rpm}$$

$$W_0^1 = 12.2 \text{ rpm}$$

$$W_+ = 25.1 \text{ rpm}$$

$$W_+/W_0 = 0.476$$

Notes: Normal erection and lock-in.

Results

Test Nos. 1 - 4 verified the structural integrity of the solar paddle arm design. Test No. 4 simulated a "zero g" spin rate of 39.3 rpm, or 1.67 times the maximum to be expected in flight.

Tests Nos. 2 and 5 - 10 showed that the paddle will erect at 12.2 rpm, but not at 4.2 rpm. Since it is not certain whether this method of testing completely simulates a "zero g" field condition for determining the lowest speed at which the paddles will properly erect and lock-in, should an orbital spin rate of 5 rpm be chosen, the following method would be used to determine whether erection springs are required. Static friction of the bearing would be measured, and the spin rate which would produce a centrifugal force large enough to give a moment on the solar paddle arm to overcome this static friction then computed.

Conclusions

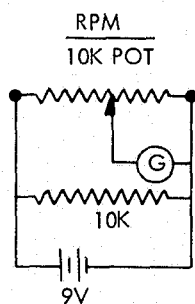
The SERB solar paddle arms are structurally sound for the intended use.

Use of erection springs is indicated if 5 rpm is selected as the orbital spin rate. A decision is required on this subject as early as possible so that the hardware may be brought to flight ready condition.

The fact that one paddle only partially locked on Test No. 2 indicates that this is near the cut-off point.

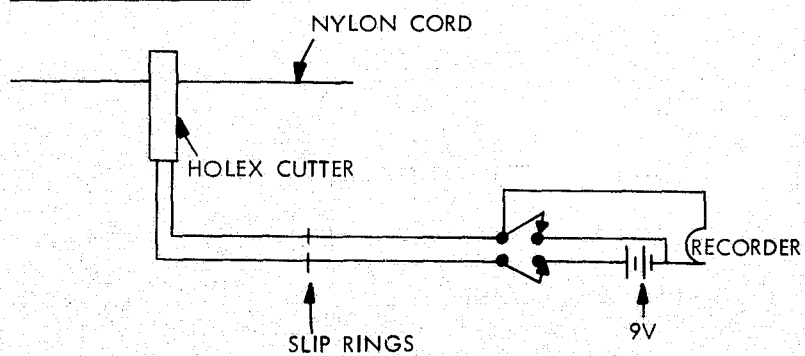
Henry J. Cornille
Space Probe and Satellite Section
Mechanical Systems Branch

SK-1



$$\text{INCHES/SEC} \div \text{INCHES/REV} \times 60 = \text{RPM}$$

RELEASE MECHANISM



S-3B PADDLE ERECTION TEST (SIMULATION RPM SPEEDS)

<u>RUN NO.</u>	<u>RPM Before Erect.</u>	<u>RPM After Erect.</u>	<u>REMARKS</u>
1	55.1	25.3	<div style="text-align: center;">↑ Film Coverage ↓</div>
2	52.7	24.8	
3	59.3	27.4	
4	64.2	28.8	
5	49.8	—	
6	50.9	—	
7	51.4	—	
8	53.3	24.9	
9	54.2	25.4	
10	53.8	25.0	

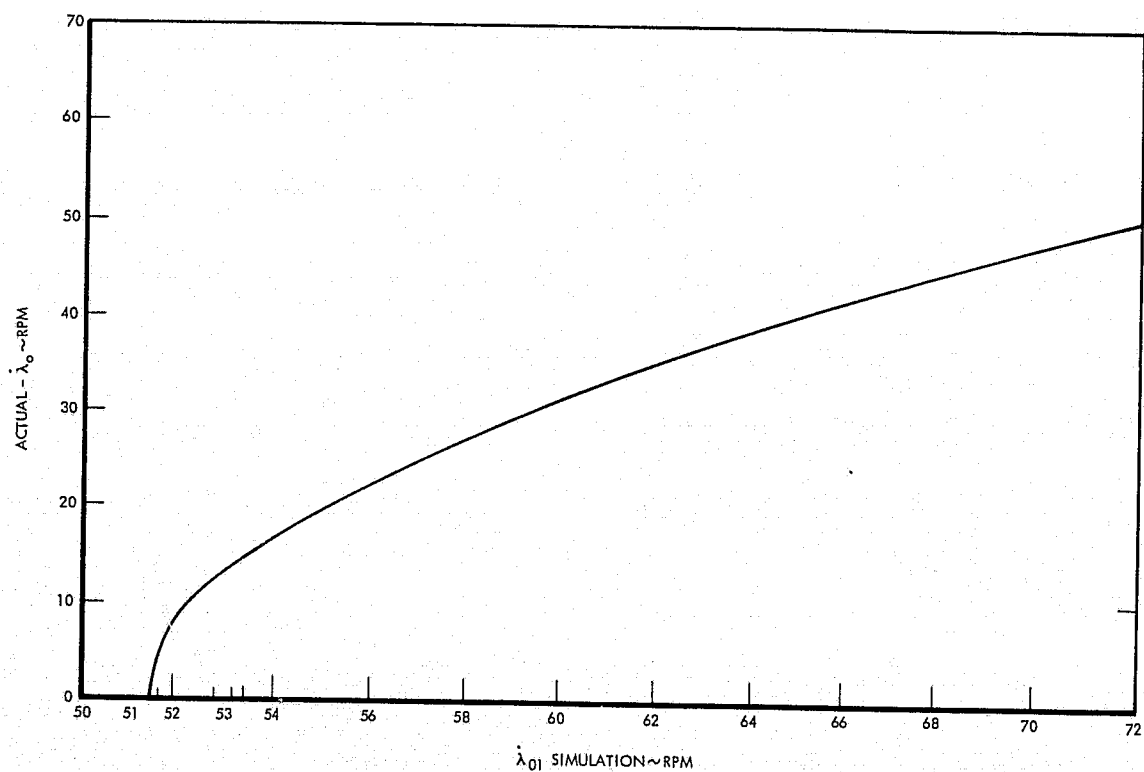
NOTE: These are corrected RPM's
17 Sept. 62
JHK

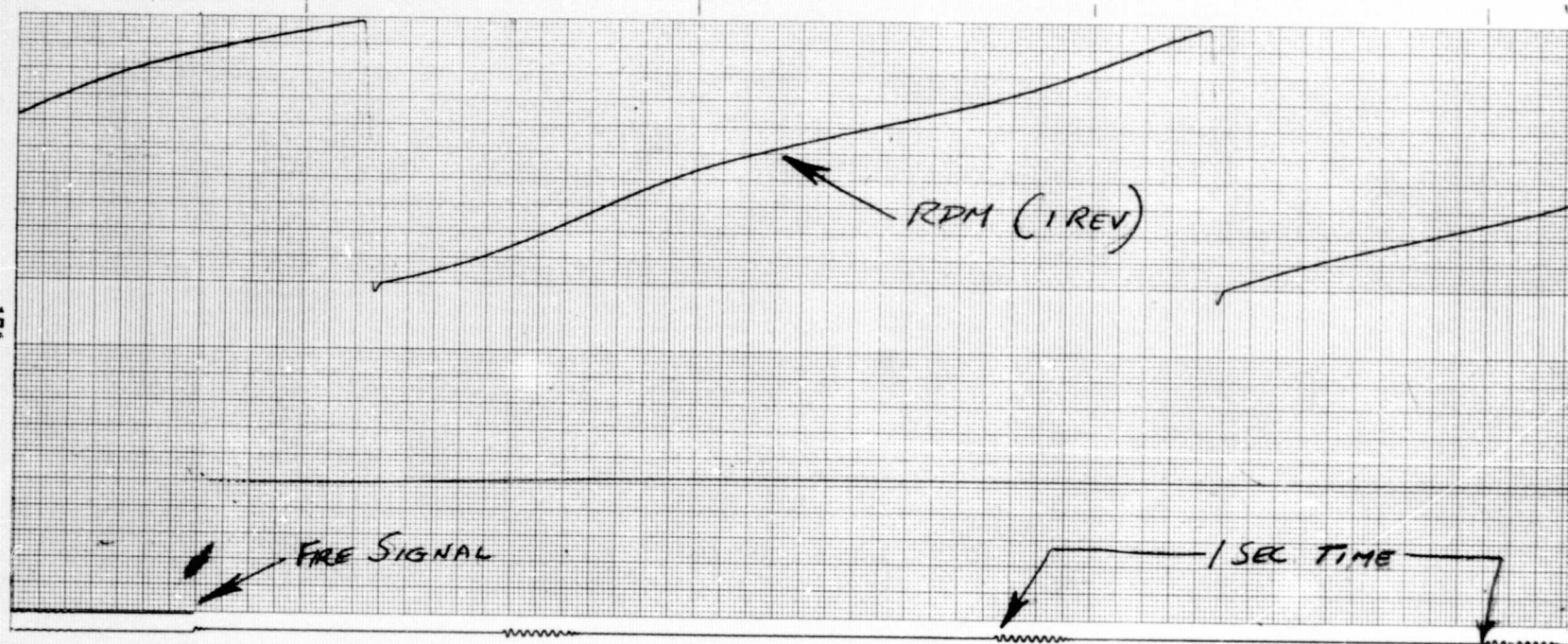
S-3B PADDLE ERECTION TEST (ACTUAL RPM)

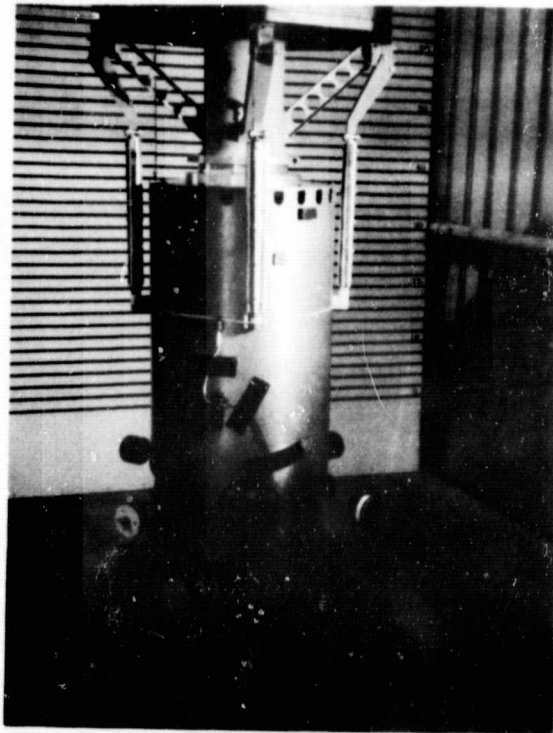
<u>RUN NO.</u>	<u>ERECTION RPM</u>
1	16.8
2	11.7
3	29.8
4	38.8
5	—
6	—
7	—
8	15.3
9	17.2
10	12.2

17 Sept. 62
JHK

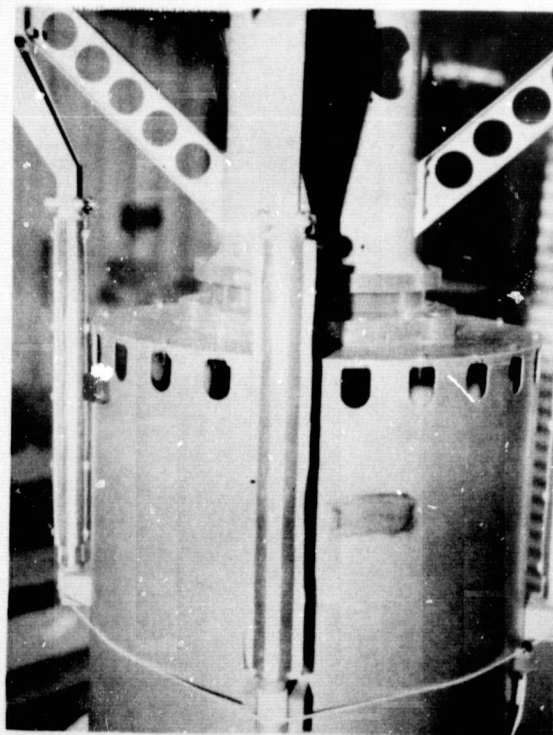
SH-3



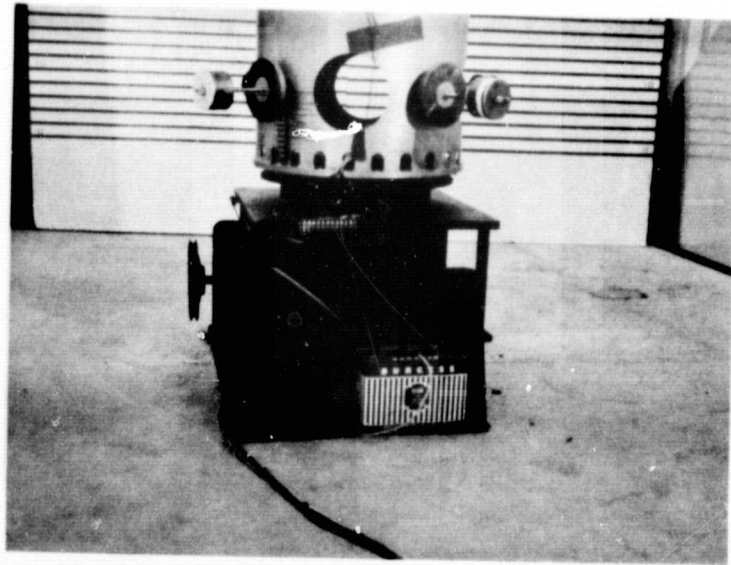
SAMPLE
RECORD



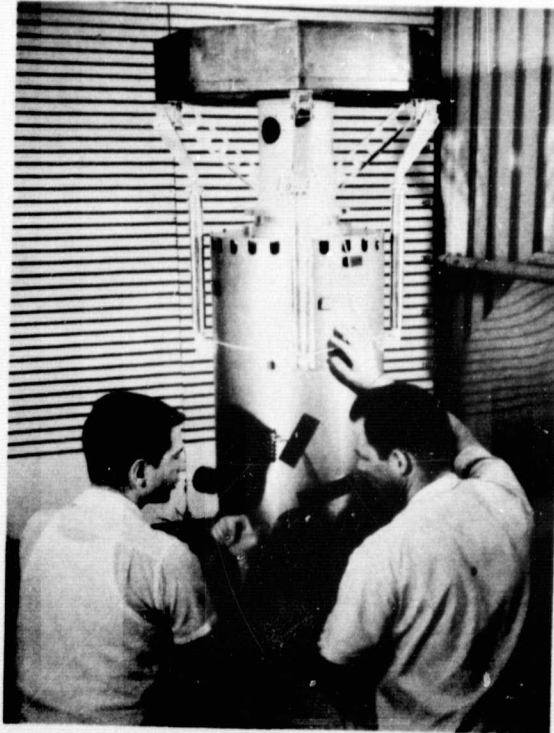
Paddle Erection Test Set-up



Paddle Erection Test Set-up



Paddle Erection Test Set-up



Paddle Erection Test Set-up

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-23

<u>JM</u>	<u>P.E.</u>
<u>FTM</u>	<u>S.H.</u>
<u>RCB</u>	<u>B.H.</u>

Name of Test: Determine Center of Gravity of Prototype (S-3)

Date of Test: 1 March 61

Requested by: J. Madey

Performed by: L. Paul and Walter E. Smith

Purpose of Test: To determine center of gravity of S-3 prototype.

Description of Article Tested (Photographs, if any):

S-3 Prototype

Test Equipment (Photographs, if any):

.250 "DIA Rod - 4' long
Standard test rig (see photo #1)

Test Procedure:

1. Rod was screwed to bracket with four #4-40 screws. Bracket was attached to payload at #1 strut position by means of four #10-32 screws. Adjustment was made in fixture by sliding payload to a position where it was equally balanced. Balance was then checked by means of a precision level. The same procedure was followed for the paddles extended and paddles folded positions.

Results:

Center of Gravity with paddles extended is 12-1/8" from base.
Center of Gravity with paddles folded is 10-9/16" from base.

Conclusions:

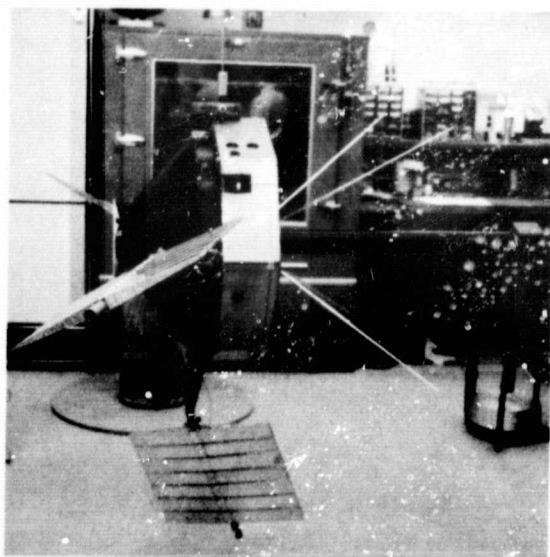


Photo No. 1

MECHANICAL SYSTEMS BRANCH
SPACECRAFT INTEGRATION AND
SOUNDING ROCKET DIVISION

INFORMAL TEST REPORT

File No. 300-38

JM	P.E.
FTM	S.H.
B	B.H.

5/9

Name of Test: Thermal Vacuum Resistor Test

Date of Test: May 61

Requested by: J. Madey

Performed by: Paul H. King

Purpose of Test: To determine amount of heat transfer when power is applied to resistor. Also to determine the operating temp. of the resistor with a 20 watt input.

Description of Article Tested (Photographs, if any):

S-3 strut and solar paddle assembly - photos attached.
(1) 20 ohm 25 watt Dale resistor

Test Equipment (Photographs, if any):

CVC Thermal Vacuum System
Millivolt recorder
D.C. voltage supply
Four thermocouples for temp. measurement
Heat sink

Test Procedure:

Placed strut and paddle arm assembly, connected to heat sink, in Bell jar. Brought vacuum down to 5×10^{-5} . Varied temp. of heat sink by means of refrigeration unit and heating coils located in Bell jar. Opened Bell jar and painted entire assembly black and mounted black shield around Bell jar and ran test over with heat sink maintained at room temperature.

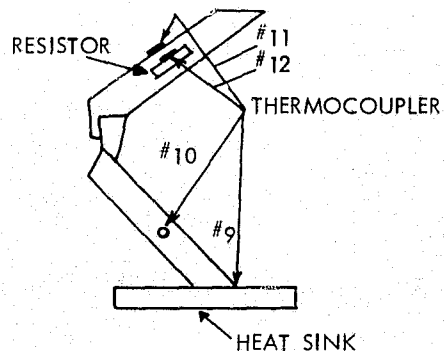
Results: (Photographs and graphs, if any):

Monitoring sheet and photos attached.

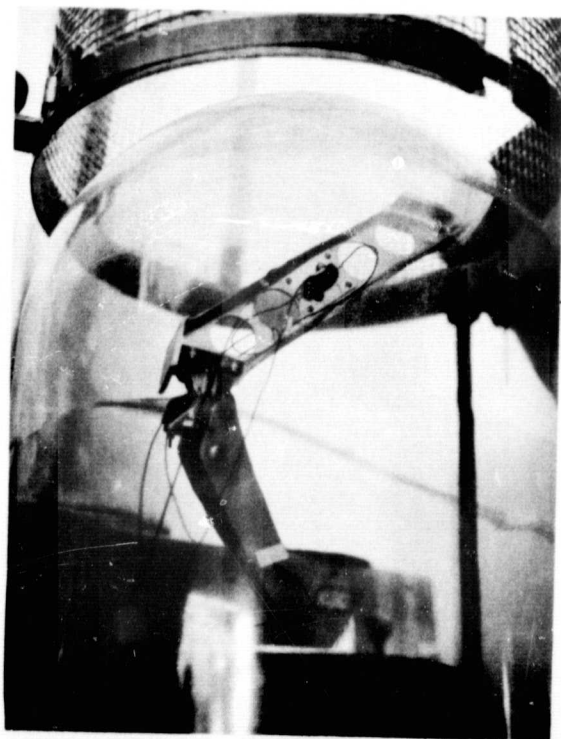
Conclusions:

The system is so designed that the payload shuts down (by relay) when the battery voltage drops below 12.6 volts, 24 hr. timer insures charging these batteries continuously for this period. Near the end of the 24 hr. period the solar cells begin dumping 14 watts power, into (2) two 25 watt resistors (hooked up in parallel). The question was; what is the power rating of these resistors in a vacuum and what would happen if the 14 watts was absorbed by (1) one resistor? As a safety factor (20) twenty watts was dumped into (1) one resistor without any apparent failures, also in the actual payload the strut will conduct a major portion of it's heat into the lower cover from where it will radiate out into outer space.

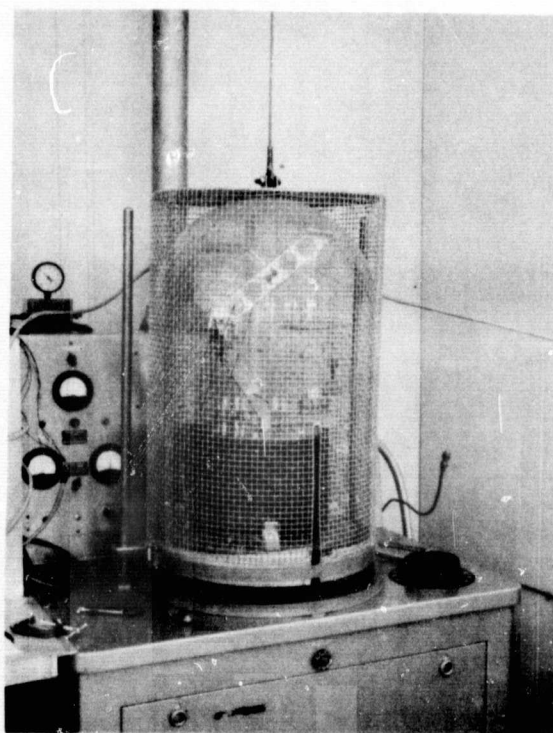
J. Madey



177



Test Set-up



Test Set-up